SCIENTIFIC AMERICAN SUPPLEMENT. No. 1230

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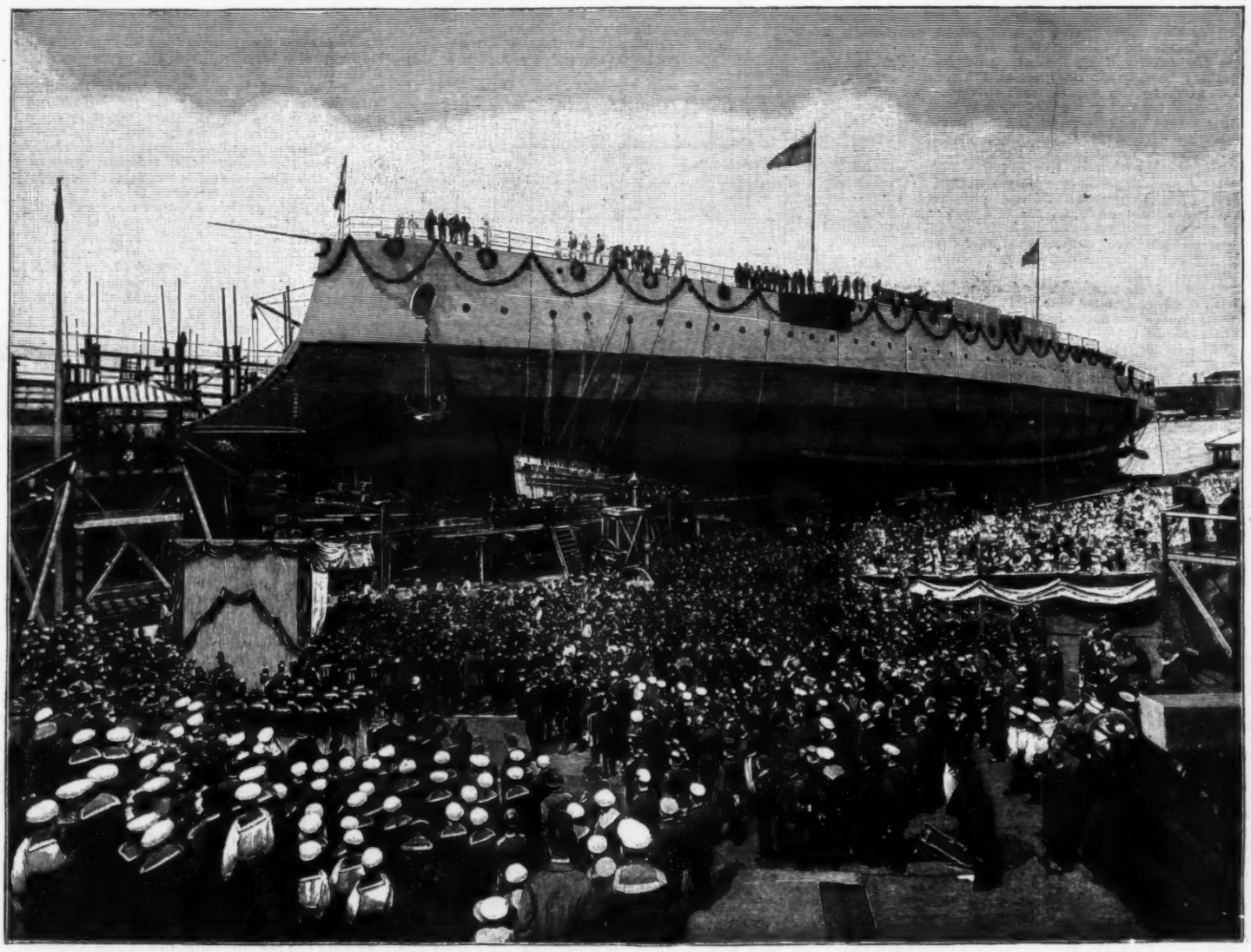
Scientific American, established 1845.
Scientific American Supplement, Vol. XLVIII, No. 1230. NEW YORK, JULY 29, 1899. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE LAUNCH OF THE "KAISER WILHELM DER GROSSE."

IN the presence of the Emperor and Empress, and the Grand Duke and Grand Duchess of Baden, the "Ersatz Kaiser Wilhelm" was launched on June 1 from the Germania yards, at Kiel, and christened "Kaiser Wilhelm der Grosse." At the bow of the vessel platforms had been built for the sponsor and the spectators. Accompanied by Staatssekretär Tirpitz and Kommerzienrath Krupp, the company ascended the sponsor's platform. The Emperor then delivered a fiery speech; the Grand Duchess of Baden broke a bottle of champagne over the prow and christened the battleship "Kaiser Wilhelm der Grosse."

The new vessel is 115 meters long (377·2 feet), has a maximum beam at the water-line of 20·4 meters (66·912 feet), and a draught amidships of 7·83 meters (25·68 feet). The maximum displacement is 12,000 tons. The engines will develop 13,000 horse power, and will drive the vessel at a speed of 18 knots per hour. Two military masts with fighting tops will be provided. The capacity of the coal bunkers will be 650 tons. The complement of officers and men will be 650. The armament will consist of thirty-four rapid-fire rifles, twelve 3·7-centimeter and eight 8·8-centimeter machine-guns. The main battery will be composed of four 24-centimeter rapid-fire guns of a length of forty calibers mounted in pairs, *en barbette* fore and aft. The secondary battery will comprise eighteen 15-centimeter rapid-fire guns, also of forty calibers length, and twelve 8·8-centimeter rapid-fire guns, all mounted in armored turrets and casemates. There are six torpedo tubes, five of which are submerged. The armor is distributed in a belt, which girdles the entire hull. The cost of the vessel will be 14,120,000 marks ($3,780,000). For additional information regarding this powerful addition to Germany's navy the reader is referred to SUPPLEMENT, No. 1221, in which the "Kaiser Friedrich III.," the sister ship of the "Kaiser Wilhelm," is fully described and illustrated. The engraving of the launch of the "Kaiser Wilhelm" was taken from Ueber Land und Meer.



THE LAUNCH OF THE "KAISER WILHELM DER GROSSE."

INCANDESCENT MANTLES.*

By VIVIAN B. LEWES, F.I.C., F.C.S.†

THERE is nothing more wearying to the practical man than to listen to the preachings of the scientist who imagines that the thoughts born within the four walls of his study are superior to the hard earned experience of years of labor, and nothing is further from my intention than to impose this suffering upon you. There are, however, sides to many questions which can be made clear; details, the explanation of which can help, and innovations, the description of which will interest those employed in actual everyday work, and it is in this way that lectures can be made most valuable, while the more practical working experiences find their most fitting record in the discussion which every lecturer hopes to excite.

It was long before the incandescent mantle came to the help of the gas engineer in his fight against the threatened encroachments of the electric light that the name of Auer von Welsbach became known to the scientific world as one of the most promising students in the domain of the rare earths that the world-famous laboratories of Heidelberg and Vienna had produced.

Boiling a solution of some of these rare oxides, and using a ragged sheet of asbestos card to shield the beaker containing the solution of the salts from the fierce flame of the Bunsen burner, he noticed that a small quantity of liquid, having boiled over and having evaporated on the projecting fibers at the edge of the card, endowed them with the power of becoming brilliantly incandescent under the exciting heat of the non-luminous flame. Seizing the clew thus obtained, Welsbach set himself to solve the problem of how to utilize the manifestly high light emissivity of these bodies as a practical aid to artificial illumination, and the result of that quest has been to place the gas industry well beyond the reach of electrical competition for many years to come, and to insure fame and more substantial reward to the keen worker whose practical appreciation of the importance of his discovery resulted in one of the most phenomenal successes of modern times.

The term "rare earths" is one of those anomalies which mar the vaunted precision of science, as although it might justly be applied to the oxides of many metals, it was in 1885 used to designate a small band of metallic oxides which occur in certain rare minerals, of which cerite and gadolinite may be taken as types.

The term "earth" was applied to such bodies as the oxide of chromium, Cr_2O_3, and alumina, Al_2O_3, while the "alkaline earths" were the calcium and magnesium groups.

These rare earths were generally considered to be: Cerium oxide, Ce_2O_3; lanthanum oxide, La_2O_3; didymium oxide, Dy_2O_3; yttrium oxide, Y_2O_3; erbium oxide, Er_2O_3; together with some others even scarcer, and these are divided into two groups:

Cerite earths.	Ytterite earths.
Cerium oxide,	Yttrium oxide,
Lanthanum oxide,	Erbium oxide,
Didymium oxide,	

which are easily divided from each other by the action of an excess of potassic sulphate, the cerite earths forming "alums" which are insoluble in potassic sulphate and so separate out, while the ytterite earths remain

* Paper read before the Institution of Gas Engineers, on May 3.—From The Progressive Age.

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in solution. These rare earths are all bases, but there are other metallic oxides, equally rare, which play an important part in mantle making but cannot be classified with them. Thoria, ThO_2, and zirconia, ZrO_2, are not earths, and in some combinations show rather an acidulous than a basic tendency. These two metals, thorium and zirconium, are classed with titanium, silicon, etc.

It was with the study of these oxides that Welsbach was most concerned at the period when his early attempts began to assume tangible shape, and having discovered the possibility of making a mantle to fit the shape of a non-luminous Bunsen flame by soaking a cotton fabric in a solution of salts of the rare earths and then burning out the organic matter in such a way as to leave a ghost of the departed threads built up of the oxides of the metals used—thin enough to be excited to luminosity by the heat of the flame, and yet resistant enough to retain its shape under the temperature to which it was submitted—he took out his celebrated patent of 1885, which has proved an efficient first line of defense against those who, left without the charmed circle, yet have hungered for the baked meats within.

In the 1885 patent, Welsbach protects the idea of making a mantle by saturating the cotton fabric and then burning off, using mixtures of the salts which he gives as "60 per cent. zirconia or oxide of zirconium, 20 per cent. oxide of lanthanum, 20 per cent. oxide of yttrium. The oxide of yttrium may be dispensed with, the composition then being 50 per cent. zirconia and 50 per cent. oxide of lathanum. Instead of using the oxide of yttrium, ytterite earth, and instead of the oxide of lanthanum, cerite earth, containing no didymium and but little cerium, may be employed."

As a commercial article, the mantles made under this patent were dire failures; they gave a candle-power which varied from 3 to 6 candles per foot of gas consumed, and were so friable that the mantles of to-day seem giants of strength as compared with their puling forefathers. They, however, fulfilled the important function of launching the idea of the mantle, and hardly had the patents been taken out than Welsbach made the further discovery that by going outside the group of rare earths, and by replacing zirconia as a basis by thoria, increased life and strength could be given to the mantle, and this was protected by the patent taken out by Welsbach in 1886.

In this patent he protects the use of thoria alone or in admixture with zirconia, lanthana, yttria, didymia, erbia, magnesia or alumina. During the next few years the composition of the mantles made by the Welsbach companies was of a very variable character, but the largest proportion of them consisted of commercial thoria and gave a light of 6 to 8 candles per foot of gas, this being due to the fact that the material used was not pure and contained traces of ceria, which gave it the power of emitting what was then a considerable amount of light.

Pure thoria gives a practically non-luminous mantle, and with chemically pure material the light obtainable is under 1 candle per cubic foot of gas, while even now a mantle made from the commercially pure thoria, manufactured for mantle making, gives a light of from 4 to 5 candles per cubic foot of gas, this being entirely due to the difficulty of separating the last traces of ceria; and as 0·1 per cent. of ceria causes the thoria to give about 5 candles per foot of gas, it is difficult to obtain a sample which does not give a certain amount of light.

The use of ceria together with thoria is mentioned in some of Welsbach's early foreign patents, but the exact date at which it was first realized that ceria in traces had the marvelous effect on the light emissivity of the thoria mantle that we find in the mantles of today is not very clear, but it is evident that the advantage of the presence of small quantities of ceria was beginning to be realized by 1891, when Mr. W. McKean, the chemist of the English Welsbach Company, read a very interesting paper before the Society of Chemical Industry and pointed out that ceria is by no means a disadvantage in small quantities, as it adds to the constancy of the illuminating power, and he gives a table showing the influence of the presence of ceria in the lighting fluid, and also the influence upon the light which increasing percentages of ceria have. Thus, for instance, the ordinary lighting fluid contains 0·25 per cent. of ceria, gives 25 candles for a consumption of 2·5 cubic feet of gas, or 10 candles per foot, while increasing the percentage of ceria in the fluid to 0·5 reduces this to 18 candles for 2·5 cubic feet, and when 1 per cent. of ceria is added, a further reduction to 13·5 candles for the 2·5 cubic feet is found; but while the candle-power lost 43·2 per cent. in 1,000 hours with the 0·25 per cent. of ceria, it only lost 12·6 per cent. in one experiment and 28 per cent. in another with 1 per cent. of ceria present in the original fluid. He also gives in the same paper as a composition for a mantle giving a yellowish light: Lanthana, 40 per cent.; thoria, 28 per cent.; zirconia, 30 cent.; ceria, 2 per cent.; showing that at this period the use of ceria in small quantities in mantles containing thoria was by no means unknown.

Later on, in 1893, Mr. Moeller, having clearly realized that commercial thoria contained traces of ceria, and that it was owing to this that the earlier mantles gave any light, took out a patent in which he sought protection for thoria in combination with very small traces, not exceeding 1 or 2 per cent., of certain other rare metals, such as uranium, cerium, terbium, neodymium, samarium, praxeodymium, yttrium and lanthanum, and the mantles of to-day nearly all consist of 99 per cent. thoria and 1 per cent. ceria; as although several of the oxides mentioned in minute traces endow a non-luminous thoria mantle with the power of emitting light, yet ceria so far transcends the others, not only in its power of exciting luminosity, but of keeping up the illuminating power over a long period, that as far as our knowledge goes it is needless to look beyond it.

An absolutely pure thoria mantle gives less than 1 candle per cubic foot of gas consumed, a pure ceria mantle gives but little light and of a red nature, so that for all practical purposes the ingredients when used alone are valueless, but the smallest addition of ceria gives a rapid leap up in its power of light emissivity, which reaches its maximum when from 0·9 to 1 per cent. of the total oxide consists of ceria, further additions causing a rapid falling off in the light, while the light emitted first assumes a yellowish and then a reddish tint as the percentage increases.

The following curve of candle-power and percentage of ceria shows the average result obtained, but it must be borne in mind that certain traces of impurities derived from the ash of the cotton and from the salts used lower to a certain degree the absolute candle-power, although they do not affect the general contour of the curve.

Several attempts have been made to explain the wonderful power of light emissivity possessed by the thoria-ceria mantle. Dr. Drossbach was of opinion that the rare earths had a special action in converting the heat rays into light rays, and that the molecules of ceria acted by bringing the heat vibrations of thoria to the most favorable state of resonance with the vibration of the hot flame gases. Dr. Moscheles and Dr. Killing both pointed out that cerium formed two oxides and that other metals having the same characteristics would act as exciters when used in the proper proportions, and both attributed the high incandescence of the mantle to changes in the state of oxidation increasing the intensity of combustion on the mantle surface, while Dr. Killing also pointed out that a catalytic action probably took place.

Dr. Bunte has given by far the best exposition of the theory of the incandescent mantle, which if it does not make all points clear, yet offers a simple and probable explanation of the observed phenomena, which he ascribes to intense local temperature due to the ceria exercising a power of attracting oxygen and causing its combination with the flame gases.

The remarkable influence which ceria exerts in awakening light emissivity in the mantle becomes still more remarkable when one considers that although the percentage by weight of the ceria is only 1, yet that by volume it is enormously less. When nitrate of cerium is converted into ceria by the action of heat but little change of volume takes place, but when nitrate of thorium is decomposed in the same way its conversion into oxide is accompanied by an increase in bulk of an extraordinary character, the substance swelling up and producing a light powder occupying many times the bulk of original salt, so that in the finished mantle small indeed must be the space occupied by the exciting ceria.

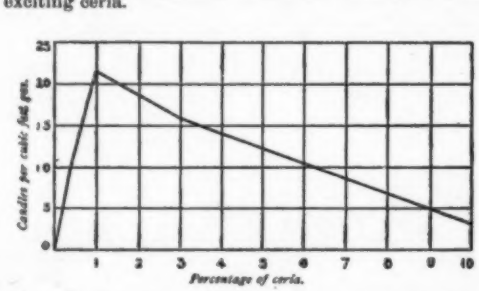


FIG. 1.—EFFECT OF CERIA UPON LIGHT EMISSION OF A THORIA-CERIA MANTLE.

This seems to point to some specific action on the part of the ceria, and cases are not uncommon in which dilution with some inert material increases physico-chemical action of the kind one would expect of the ceria. If port or claret be shaken up with powdered charcoal, which consists of nearly pure carbon, and the mixture is then filtered, the color is but little changed, while if animal charcoal or some of the artificially prepared imitations of it containing less than 10 per cent. of carbon distributed over the surface of inert mineral matter be used for the same purpose, the liquid is absolutely decolorized.

Another example which bears closely upon the case of the ceria is to be found in the action of platinum upon mixtures of hydrogen or coal gas and air. If a piece of platinum foil be heated to redness in a Bunsen flame, and the gas be then turned out and again turned on before the platinum has had time to grow too cool, it again becomes heated to redness in the stream of gas and air and continues in that condition as long as the gases are passing over its surface; while if brought to what would have been the outer envelope of the flame had the gaseous mixture been alight, the temperature is so increased that the ignition point of the gas is reached. The action here is what is known as catalytic or surface action, and is due to the fact that platinum has the power of condensing gases upon its surface, and in doing so renders them so chemically active that combination between the condensed gases is often induced, and in the case of the coal-gas and air enough heat is evolved on the surface of the platinum to raise it to redness. The result being due to surface action, it is manifest that an increase of the surface must increase the activity of the substance, and if instead of taking metallic foil with its comparatively small area of exposed surface, spongy platinum made by reduction from platinum salt or asbestos coated with the reduced metal be employed, ignition of the gaseous mixture without the preliminary heating takes place.

The fact that the platinum foil remains red hot in the stream of coal gas and air which is only at atmospheric temperature at once shows that the heat evolved by such an action is localized in the body starting the action, and it is manifestly possible, and indeed probable, that the very minute particles of ceria scattered over the surface of the inert thoria and so subdivided as to be capable of easy and rapid heating to a very high temperature may give rise to an action of the same kind. Indeed, one knows that to a certain extent this is so, because if the mantle burner be turned off and again turned on while the mantle is still hot, the mixture of gas and air is reignited, although the rod and mantle material are manifestly below the ignition point of the gas, and the fact that this does not take place with a pure thoria mantle is a fairly good proof that it is the ceria and not the thoria which is acting.

Dr. Bunte has found that thoria had no influence in bringing about the combination of hydrogen and oxygen, and the temperature at which the two combined to form water was the same whether thoria was present or not, but that the presence of ceria caused them to combine at 660° Fah. instead of 1,200° Fah. This being so, the question arises as to what the action can be that the ceria induces, the localization of the heat from which causes its minute and subdivided particles to glow with so high an incandescence.

When in a Bunsen burner the admixture of gas and air has been carried to the extreme limit, so that what would have been the inner cone of the Bunsen flame settles down as a green and seething sheet on the gauze of the burner top, being indeed only prevented from flashing back in the tube by the conducting power of the gauze and the accelerated rush of the gas and air mixture through its meshes, the combustion is being completed in two stages, the first taking place on the surface of the gauze where the hydro-carbons of the coal-gas undergo incomplete combustion at the expense of the oxygen of the admixed air yielding carbon monoxide and hydrogen, together with small quantities of carbon dioxide and water vapor, and it is the combustion of the carbon monoxide and hydrogen which gives the outer flame in which the mantle is heated, this combustion entirely taking place at the expense of the oxygen derived from the air surrounding the flame and not from the air originally mixed with the gas in the burner tube. It is a mistake to speak of this outer flame as a "solid flame," an expression often used in connection with burners in which sufficient air is introduced with the gas to flatten the inner zone on to the gauze, as it is merely the structureless flame which is always obtained on burning gases like carbon monoxide and hydrogen which burn only in one stage. Any user of mantles knows perfectly well that it is only in the edge of this outer flame that the mantle material acquires its true incandescence, this being due to the fact that it is only when the maximum quantity of air and the carbon monoxide and hydrogen meet that the highest temperature is attained, and it is here that combustion is at its fiercest and that the catalytic action of the ceria creates points of high intensity.

The view put forward by Moscheles and Killing may be shortly stated as follows: Cerium is a metal which exists in two states of oxidation, a lower or cerous oxide, Ce_2O_3, and a higher or ceric oxide, CeO_2, and it is easily conceivable that in its highly subdivided condition and at a high temperature, exposed as it is to the high reducing action of hydrogen and carbon monoxide, which tend to take oxygen from it and convert it into cerous oxide, and also to the oxidizing action of the air, which tends to again build it up into ceric oxide, a continual oxidation and reduction is taking place, the abstraction of oxygen from the air and its liberation to combine with reducing gases on the surface of the ceria raising these attenuated particles far above the temperature of the flame.

It is quite clear that whether one accepts the Killing theory of dual oxidation, or Bunte's of catalytic action of the ceria, one arrives at an explanation of the fact that unless the mantle be just in the right position so that both the air and flame gases have access to it, the luminosity is practically destroyed.

It may be roughly stated that there now exist two classes of theory with regard to the mantle, the first being that the ceria or ceria and thoria exercise some occult power in converting heat rays into light, and the second, the theories of Killing and Bunte, which ascribe the wonderful light emissivity to the exalted temperature brought about by local combination due to the power of the ceria in attracting oxygen, and it matters but little whether this be brought about by a purely chemical or by a physico-chemical action.

It is clear that if the light be due to the conversion of heat rays into light, on heating the material out of contact with air, the same differences in their power of emitting light should be observed as exist in the mantle, and several experiments have been made in order to find if this were so or not.

Dr. Bunte took a thick-walled tube of arc carbon, having the walls of its middle portion reduced for a length of 4 inches to a thickness of 0·059 inch, and heated it by an electric current until the middle portion attained a most intense white heat far above 3,630° Fah. In order to prevent combustion and loss of heat, the middle of the tube was embedded in magnesia over which asbestos was wrapped. Small square prisms—0·59 inch long by 0·28 inch wide—of magnesia were coated with the substances to be examined, and each was cemented to a similarly shaped piece of carbon or magnesia, so that the two adjoining faces consisted of the two substances to be compared. On placing these double prisms in the tube, it was possible with certain precautions to observe the relative intensities of the radiation by comparing the two halves of the surface visible in the tube. These researches showed very small differences in the intensity of the radiation from carbon, magnesia, pure oxides of thorium and cerium, and the Welsbach mixture.

(To be continued.)

RULES FOR CONDUCTING BOILER TRIALS.

(Code of 1899, A. S. M. E.)

FROM The Locomotive we take the following concerning the recommendations of the American Society of Mechanical Engineers relative to the method of conducting boiler trials:

I. Determine at the outset the specific object of the proposed trial, whether it be to ascertain the capacity of the boiler, its efficiency as a steam generator, its efficiency and its defects under usual working conditions, the economy of some particular kind of fuel, or the effect of changes of design, proportion, or operation; and prepare for the trial accordingly.

II. Examine the boiler, both outside and inside; ascertain the dimensions of grates, heating surfaces, and all important parts; and make a full record describing the same, and illustrating special features by sketches. The area of heating surface is to be computed from the surfaces of shells, tubes, furnaces, and fire-boxes in contact with the fire or hot gases. The outside diameter of water-tubes and the inside diameter of fire-tubes are to be used in the computation. All surfaces below the mean water level which have water on one side and products of combustion on the other are to be considered as water-heating surface, and all surfaces above the mean water level which have steam on one side and products of combustion on the other are to be considered as superheating surface.

III. Notice the general condition of the boiler and

its equipment, and record such facts in relation thereto as bear upon the objects in view. If the object of the trial is to ascertain the maximum economy or capacity of the boiler as a steam generator, the boiler and all its appurtenances should be put in first-class condition. Clean the heating surface inside and outside, remove clinkers from the grates and from the sides of the furnace. Remove all dust, soot, and ashes from the chambers, smoke connections, and flues. Close air leaks in the masonry and around poorly fitted cleaning doors. See that the damper will open wide and close tight. Test for air leaks by firing a few shovels of smoky fuel and immediately closing the damper, observing the escape of smoke through the crevices, or by passing the flame of a candle over cracks in the brickwork.

IV. Determine the character of the coal to be used. For tests of the efficiency or capacity of the boiler for comparison with other boilers the coal should, if possible, be of some kind which is commercially regarded as a standard. For New England and that portion of the country east of the Allegheny Mountains, good anthracite egg coal, containing not over 10 per cent. of ash, and semi-bituminous Clearfield (Pa.), Cumberland (Md.), and Pocahontas (Va.) coals are thus regarded. West of the Allegheny Mountains, Pocahontas (Va.) and New River (W. Va.) semi-bituminous and Youghiogheny or Pittsburg bituminous coals are recognized as standards. (These coals are selected because they are about the only coals which contain the essentials of excellence of quality, adaptability to various kinds of furnaces, grates, boilers, and methods of firing, and wide distribution and general accessibility in the markets.) There is no special grade of coal mined in the Western States which is widely recognized as of superior quality, or considered as a standard coal for boiler testing. Big Muddy lump, an Illinois coal mined in Jackson County, Ill., is suggested as being of sufficiently high grade to answer the requirements in districts where it is more conveniently obtainable than the other coals mentioned above. For tests made to determine the performance of a boiler with a particular kind of coal, such as may be specified in a contract for the sale of a boiler, the coal used should not be higher in ash and in moisture than that specified, since increase in ash and moisture above a stated amount is apt to cause a falling off of both capacity and economy in greater proportion than the proportion of such increase.

V. Establish the correctness of all apparatus used in the test for weighing and measuring. These are:

1. Scales for weighing coal, ashes and water.
2. Tanks or water meters for measuring water. Water meters, as a rule, should only be used as a check on other measurements. For accurate work, the water should be weighed or measured in a tank.
3. Thermometers and pyrometers for taking temperatures of air, steam, feed-water, waste gases, etc.
4. Pressure gages, draught gages, etc.

The kind and location of the various pieces of testing apparatus must be left to the judgment of the person conducting the test; always keeping in mind the main object, which is to obtain full and accurate data.

VI. See that the boiler is thoroughly heated, before the trial, to its usual working temperature. If the boiler is new and of a form provided with a brick setting, it should be in regular use at least a week before the trial, so as to dry and heat the walls. If it has been laid off and become cold, it should be worked before the trial until the walls are well heated.

VII. The boiler and connections should be proved to be free from leaks before beginning a test, and all water connections, including blow and extra feed pipes, should be disconnected, stopped with blank flanges, or bled through special openings beyond the valves, except the particular pipe through which water is to be fed to the boiler during the trial. During the test, the blow-off and feed pipes should remain exposed to view. If an injector is used, it should receive steam directly through a felted pipe from the boiler being tested. (In feeding a boiler undergoing test with an injector taking steam from another boiler, or the main steam pipe from several boilers, the evaporative results may be modified by a difference in the quality of the steam from such source compared with that supplied by the boiler being tested, and in some cases the connection to the injector may act as a drip for the main steam pipe. If it is known that the steam from the main pipe is of the same quality as that furnished by the boiler undergoing the test, the steam may be taken from such main pipe.) If the water is metered after it passes the injector, its temperature should be taken at the point where it leaves the injector. If the quantity is determined before it goes to the injector, the temperature should be determined on the suction side of the injector; and if no change of temperature occurs other than that due to the injector, the temperature thus determined is properly that of the feed-water. When the temperature changes between the injector and the boiler, as by the use of a heater, or by radiation, the temperature at which the water enters and leaves the injector and that at which it enters the boiler should all be taken. The final temperature, corrected for the heat received from the injector, will be the true feed-water temperature. Thus, if the injector receives water at 50 degrees and delivers it at 120 degrees into a heater which raises it to 210 degrees, the corrected temperature is 210 —(120—50) = 140 degrees. See that the steam main is so arranged that water of condensation cannot run back into the boiler.

VIII. Duration of the Test.—For tests made to ascertain either the maximum economy or the maximum capacity of a boiler, irrespective of the particular class of service for which it is regularly used, the duration should be at least 10 hours of continuous running. If the rate of combustion exceeds 25 pounds of coal per square foot of grate surface per hour, it may be stopped when a total of 250 pounds of coal has been burned per square foot of grate. In cases where the service requires continuous running for the whole 24 hours of the day, with shifts of firemen a number of times during that period, it is well to continue the test for at least 24 hours. When it is desired to ascertain the performance under the working conditions of practical running, whether the boiler be regularly in use 24 hours a day or only a certain number of hours out of each 24, the fires being banked the balance of the time, the duration should not be less than 24 hours.

IX. Starting and Stopping a Test.—The conditions of the boiler and furnace in all respects should be, as nearly as possible, the same at the end as at the beginning of the test. The steam pressure should be the same; the water level the same; the fire upon the grates should be the same in quantity and condition; and the walls, flues, etc., should be of the same temperature. Two methods of obtaining the desired equality of conditions of the fire may be used, viz.: those which were called, in the code of 1885, "the standard method," and "the alternate method," the latter employed where it is inconvenient to make use of the standard method. (The committee concludes that it is best to retain the designations "standard" and "alternate," since they have become widely known and established in the minds of engineers and in the reprints of the code of 1885. Many engineers prefer the "alternate" to the "standard" method on account of its being less liable to error due to cooling of the boiler at the beginning and end of a test.)

X. Standard Method of Starting and Stopping a Test.—Steam being raised to the working pressure, remove rapidly all the fire from the grate, close the damper, clean the ash pit, and as quickly as possible start a new fire with weighed wood and coal, noting the time and the water level while the water is in a quiescent state, just before lighting the fire. (The gage glass should not be blown out within an hour before the water level is taken at the beginning and end of a test; otherwise an error in the reading of the water level may be caused by a change in the temperature and density of the water in the pipe leading from the bottom of the glass into the boiler.) At the end of the test remove the whole fire, which has been burned low, clean the grates and ash pit, and note the water level when the water is in a quiescent state, and record the time of hauling the fire. The water level should be as nearly as possible the same as at the beginning of the test. If it is not the same, a correction should be made by computation, and not by operating the pump after the test is completed.

XI. Alternate Method of Starting and Stopping a Test.—The boiler being thoroughly heated by a preliminary run, the fires are to be burned low and well cleaned. Note the amount of coal left on the grate as nearly as it can be estimated; note the pressure of steam and the water level. Note the time and record it as the starting time. Fresh coal which has been weighed should now be fired. The ash pits should be thoroughly cleaned at once after starting. Before the end of the test the fires should be burned low, just as before the start, and the fires cleaned in such a manner as to leave a bed of coal on the grate of the same depth, and in the same condition, as at the start. When this stage is reached, note the time and record it as the stopping time. The water level and steam pressure should previously be brought as nearly as possible to the same point as at the start. If the water level is not the same as at the start, a correction should be made by computation, and not by operating the pump after the test is completed.

XII. Uniformity of Conditions.—In all trials made to ascertain maximum economy or capacity, the conditions should be maintained uniformly constant. Arrangements should be made to dispose of the steam so that the rate of evaporation may be kept the same from beginning to end. This may be accomplished in a single boiler by carrying the steam through a waste steam pipe, the discharge from which can be regulated as desired. In a battery of boilers, in which only one is tested, the draft can regulated on the remaining boilers, leaving the test boiler to work under a constant rate of production. Uniformity of conditions should prevail as to the pressure of steam, the height of water, the rate of evaporation, the thickness of fire, the times of firing and quantity of coal fired at one time, and as to the intervals between the times of cleaning the fires. The method of firing to be carried on in such tests should be dictated by the expert or person in responsible charge of the test, and the method adopted should be adhered to by the fireman throughout the test.

XIII. Keeping the Records.—Take note of every event connected with the progress of the trial, however unimportant it may appear. Record the time of every occurrence and the time of taking every weight and every observation. The coal should be weighed and delivered to the fireman in equal proportions, each sufficient for not more than one hour's run, and a fresh portion should not be delivered until the previous one has all been fired. The time required to consume each portion should be noted, the time being recorded at the instant of firing the last of each portion. It is desirable that at the same time the amount of water fed into the boiler should be accurately noted and recorded, including the height of the water in the boiler, and the average pressure of steam and temperature of feed during the time. By thus recording the amount of water evaporated by successive portions of coal, the test may be divided into several periods if desired, and the degree of uniformity of combustion, evaporation, and economy analyzed for each period. In addition to these records of the coal and the feed water, half hourly observations should be made of the temperature of the feed water, of the flue gases, of the external air in the boiler room, of the temperature of the furnace when a furnace pyrometer is used, also of the pressure of steam, and of the readings of the instruments for determining the moisture in the steam. A log should be kept on properly prepared blanks containing columns for record of the various observations. When the "standard method" of starting and stopping a test is used, the hourly rate of combustion and of evaporation and the horse power should be computed from the records taken during the time when the fires are in active condition. This time is somewhat less than the actual time which elapses between the beginning and end of the run. The loss of time due to kindling the fire at the beginning and burning it out at the end makes this course necessary.

XIV. Quality of Steam.—The percentage of moisture in the steam should be determined by the use of either a throttling or a separating steam calorimeter. The sampling nozzle should be placed in the vertical steam pipe rising from the boiler. It should be made of ½-inch pipe, and should extend across the diameter of the steam pipe to within half an inch of the opposite side, being closed at the end and perforated with not less than twenty ⅛-inch holes equally distributed along and around its cylindrical surface, but none of these holes should be nearer than ½ inch to the inner side of the steam pipe. The calorimeter and the pipe leading to it should be well covered with felting. Whenever the indications of the throttling or separating calorimeter show that the percentage of moisture is irregular, or occasionally in excess of three per cent., the results should be checked by a steam separator placed in the steam pipe as close to the boiler as convenient, with a calorimeter in the steam pipe just beyond the outlet from the separator. The drip from the separator should be caught and weighed, and the percentage of moisture computed therefrom added to that shown by the calorimeter. Superheating should be determined by means of a thermometer, placed in a mercury well inserted in the steam pipe. The degree of superheating should be taken as the difference between the reading of the thermometer for superheated steam and the readings of the same thermometer for saturated steam at the same pressure as determined by a special experiment, and not by reference to steam tables.

XV. Sampling the Coal and Determining its Moisture.—As each barrow load or fresh portion of coal is taken from the coal pile a representative shovelful is selected from it or placed in a barrel or box in a cool place and kept until the end of the trial. The samples are then mixed and broken into pieces not exceeding one inch in diameter, and reduced by the process of repeated quartering and crushing until a final sample weighing about five pounds is obtained, and the size of the larger pieces is such that they will pass through a sieve with ¼-inch meshes. From this sample two 1-quart air-tight glass preserving jars, or other air-tight vessels which will prevent the escape of moisture from the sample, are to be promptly filled, and these samples are to be kept for subsequent determinations of moisture and of heating value and for chemical analysis. During the process of quartering, when the sample has been reduced to about one hundred pounds, a quarter to a half of it may be taken for an approximate determination of moisture. This may be made by placing it in a shallow iron pan, not over 3 inches deep, carefully weighing it, and setting the pan in the hottest place that can be found on the brickwork of the boiler setting or flues, keeping it there for at least twelve hours and then weighing it. The determination of moisture thus made is believed to be approximately accurate for anthracite and semi-bituminous coals, and also for Pittsburg or Youghiogheny coal; but it cannot be relied upon for coals mined west of Pittsburg, or for other coals containing inherent moisture. For these latter coals it is important that a more accurate method be adopted. The method recommended by the committee for all accurate tests, whatever the character of the coal, is described as follows: Take one of the samples contained in the glass jars, and subject it to a thorough air-drying by spreading it in a thin layer and exposing it for several hours to the atmosphere of a warm room, weighing before and after, thereby determining the quantity of surface moisture it contains. Then crush the whole of it by running it through an ordinary coffee mill, adjusted so as to produce somewhat coarse grains (less than ⅛ inch), thoroughly mix the crushed sample, select from it a portion of from 10 to 50 grammes, weigh it in a balance which will easily show a variation as small as 1 part in 1,000, and dry it in an air or sand bath at a temperature between 240° and 280° Fah. for one hour. Weigh it and record the loss, then heat and weigh it again repeatedly, at intervals of an hour or less, until the minimum weight has been reached and the weight begins to increase by oxidation of a portion of the coal. The difference between the original and the minimum weight is taken as the moisture in the air-dried coal. This moisture test should preferably be made on duplicate samples, and the results should agree within 0·3 to 0·4 of one per cent. the mean of the two determinations being taken as the correct result. The sum of the percentage of moisture thus found and the percentage of surface moisture previously determined is the total moisture.

XVI. Treatment of Ashes and Refuse.—The ashes and refuse are to be weighed in a dry state. If it is found desirable to show the principal characteristics of the ash, a sample should be subjected to a proximate analysis, and the actual amount of incombustible material determined. For elaborate trials a complete analysis of the ash and refuse should be made.

XVII. Calorific Tests and Analysis of Coal.—The quality of the fuel should be determined either by heat test or by analysis, or by both. The rational method of determining the total heat of combustion is to burn the sample of coal in an atmosphere of oxygen gas, the coal to be sampled as directed in Article XV. of this code. The chemical analysis of the coal should be made only by an expert chemist. The total heat of combustion computed from the results of the ultimate analysis may be obtained by the use of Dulong's formula (with constants modified by recent determinations), viz.: $14{,}600\ C + 62{,}000\left(H - \frac{O}{8}\right) + 4{,}000\ S$, in which C, H, O, and S refer to the proportions of carbon, hydrogen, oxygen and sulphur, respectively, as determined by the ultimate analysis. It is desirable that a proximate analysis should be made, thereby determining the relative proportions of volatile matter and fixed carbon. These proportions furnish an indication of the leading characteristics of the fuel, and serve to fix the class to which it belongs. As an additional indication of the characteristics of the fuel, the specific gravity should be determined.

XVIII. Analysis of Flue Gases.—The analysis of the flue gases is an especially valuable method of determining the relative value of different methods of firing, or of different kinds of furnaces. In making these analyses, great care should be taken to procure average samples, since the composition is apt to vary at different points of the flue. The composition is also apt to vary from minute to minute, and for this reason the drawings of gas should last a considerable period of time. Where complete determinations are desired, the analyses should be intrusted to an expert chemist.

XIX. Smoke Observations.—It is desirable to have a uniform system of determining and recording the quantity of smoke produced where bituminous coal is used. The system commonly employed is to express

the degree of smokiness by means of percentages dependent upon the judgment of the observer. The committee does not place much value upon a percentage method, because it depends so largely upon the personal element; but if this method is used, it is desirable that, so far as possible, a definition be given in explicit terms as to the basis and method employed in arriving at the percentage. The actual measurement of a sample of soot and smoke by some form of meter is to be preferred.

XX. Miscellaneous.—In tests for purposes of scientific research, in which the determination of all the variables entering into the test is desired, certain observations should be made which are, in general, unnecessary for ordinary tests. These are the measurement of the air supply, the determination of its contained moisture, the determination of the amount of heat lost by radiation, of the amount of infiltration of air through the setting, and (by condensation of all the steam made by the boiler) of the total heat imparted to the water. As these determinations are rarely undertaken, it is not deemed advisable to give directions for making them.

XXI. Calculations of Efficiency.—Two methods of defining and calculating the efficiency of a boiler are recommended. They are:

$$1.\ \text{Efficiency of the boiler} = \frac{\text{Heat absorbed per pound combustible}}{\text{Heating value of 1 pound combustible}}$$

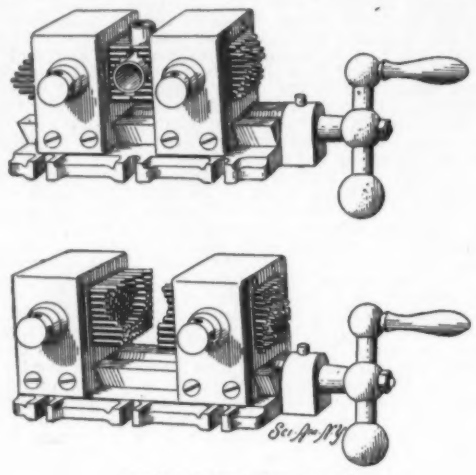
$$2.\ \text{Efficiency of the boiler and grate} = \frac{\text{Heat absorbed per pound coal}}{\text{Heating value of 1 pound coal}}$$

The first of these is sometimes called the efficiency based on combustible, and the second the efficiency based on coal. The first is recommended as a standard of comparison for all tests, and this is the one which is understood to be referred to when the word efficiency alone is used without qualification. The second, however, should be included in a report of a test, together with the first, whenever the object of the test is to determine the efficiency of the boiler and furnace together with the grate (or mechanical stoker), or to compare different furnaces, grates, fuels, or methods of firing. The heat absorbed per pound of combustible (or per pound of coal) is to be calculated by multiplying the equivalent evaporation from and at 212° per pound of combustible (or coal) by 965·7.

XXII. The Heat Balance.—An approximate "heat balance," or statement of the distribution of the heating value of the coal among the several items of heat utilized and heat lost, may be included in the report of a test when analyses of the fuel and of the chimney gases have been made. [A blank form for stating this "heat balance" is given in the report. Extensive blank forms are also given for presenting the entire data and results of the trial; but for these we must refer the reader to the original paper, which will be published in full in volume XX of the Transactions of the American Society of Mechanical Engineers.]

A NOVEL VISE.

SOME of the most expensive work that a manufacturing engineer has to undertake is the construction of jigs, rigs, and chucks, for holding irregularly shaped pieces of work for machining, or occasionally for hand



AUTOMATIC JIG VISE.

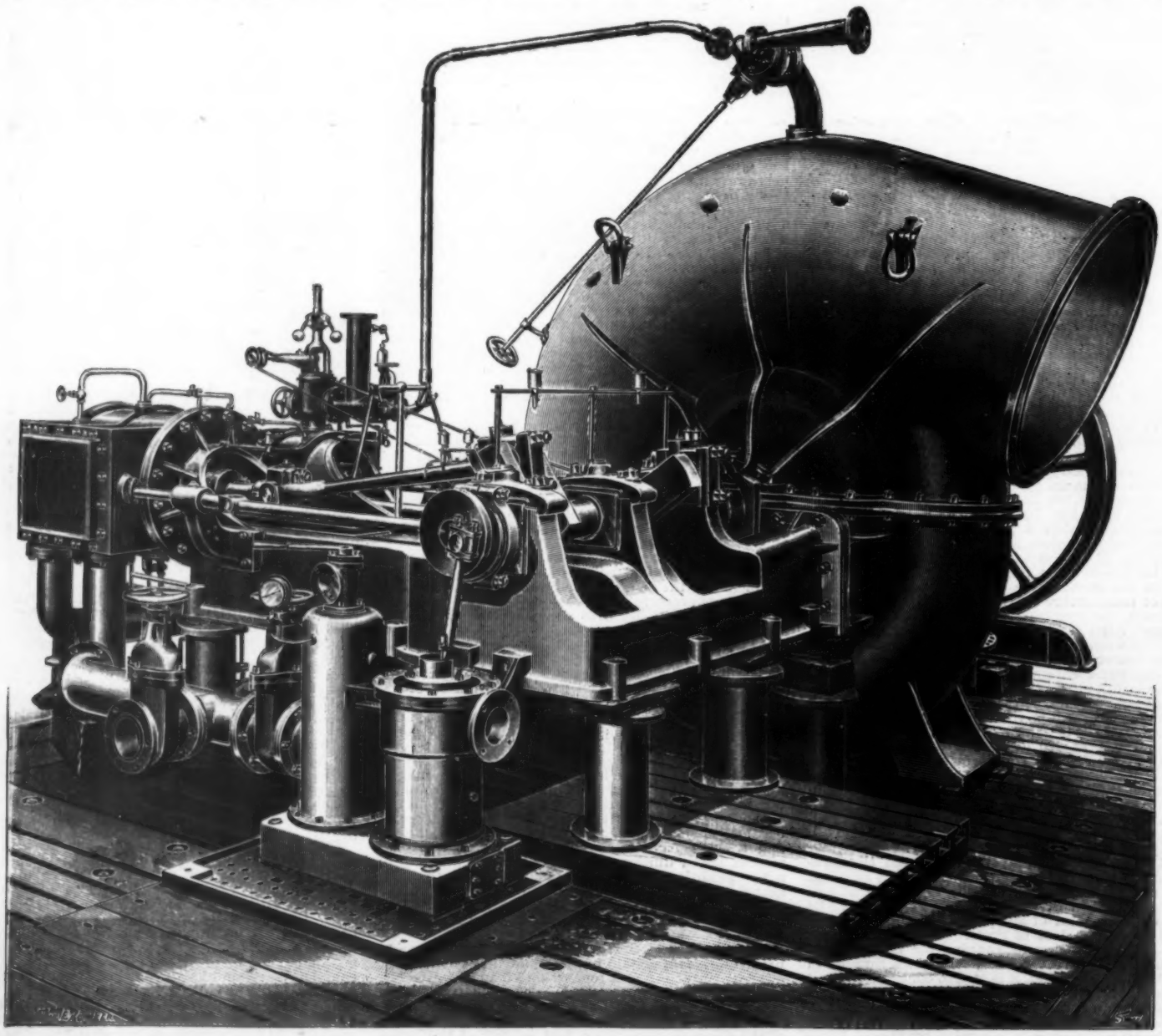
work. Where a large number of similar articles has to be made, of course it pays to go to some expense in this direction, but where only a few are required the cost is considerably increased by the outlay on the chucks required. With a view to meeting this difficulty, and removing the necessity of constructing a new set of jigs for every new set of patterns, Mr. E. Hy. Jones, of London, has invented the ingenious vise illustrated by the annexed cuts. As will be seen, the type shown is intended principally for bolting to the table of a drilling machine, but other designs suitable for a lathe chuck and for an ordinary bench vise are in hand. The vise consists of two frames or boxes which slide on a well-proportioned rest, and are moved by a right and left hand screw rotated by a handle. Each box is completely filled with a large number of small hexagon mild steel pins, the ends of which are reduced so as to leave a shoulder, and to act as a guide. On each one there fits a small spiral spring, which, by pressing against the shoulder of the hexagonal part, and against a back plate through which the shanks pass, drives the pin forward. On account of their shape the pins all pack together into the box or frame like a honeycomb. In each box there is a clamping plate and screw. The manner of using the vise is as follows: If it is desired to drill out such a piece as one of the steel tees or elbows used in bicycle construction, a cleaned-up but unmachined casting of one is taken, and is driven fairly tightly onto a drill or spindle fixed in the drilling machine. The vise is then brought into position under it, the clamping screws loosened, and the handle turned, so that the casting is pressed between the jaws. It is evident that an impress of each half of the casting will be left on the flexible faces of the vise, some of the bars projecting further than others, according to the shape of the piece; and if the jaws are then clamped up while the piece is in position, a rigid mould will be left, and a jig formed with little trouble and in little time.

Further explanation is unnecessary. We have examined one of these vises very carefully and critically, and have no hesitation in recommending it highly, both as a strong and well-made tool, and one that would prove very useful in engineers' shops. We expected that on account of the large surfaces in contact and the smallness of the springs there would be some trouble in getting the bars to follow the shape of the work. This does not appear to be the case, and as all the bars are quite independent, and can be removed instantly when cleaning is necessary, we do not see why the vise should not work just as well in a workshop as it does in a show-room.—The Engineer.

A LARGE CENTRIFUGAL PUMP.

As the difficulties due to the competition of bounty-assisted beet sugar with the cane sugar grown in the West Indies have been for some considerable time before the public, we think particulars of a large pumping plant recently sent to British Guiana may be of general interest, showing, as it does, the care taken to reduce expense in sugar growing, by using economical plants for drainage, etc., and also the large scale of working and the considerable cost of machinery necessary for such work.

The illustration shows a large centrifugal pump driven direct by a coupled compound condensing engine, which is now being erected on the Port Mourant



SEVENTY-FOUR-INCH CENTRIFUGAL PUMP.

estate of Messrs. J. McConnell & Company, at Berbice, and will easily raise and discharge 300 tons—67,200 gallons—of water per minute. The pump is of cast iron, connected at the side to the engine frame; the suction and delivery branches are 54 inches diameter; the pump disk is 74 inches diameter, and is keyed to a steel spindle which has a half coupling forged on, and is connected by taper bolts to the half coupling on the engine crank shaft. The engine is arranged to work with steam pressures of 120 pounds to 150 pounds per square inch, and has high pressure cylinder 13 inches diameter, low pressure cylinder 25 inches diameter, both with stroke 24 inches; both cylinders are steam jacketed, lagged with asbestos and covered with sheet steel; the high pressure cylinder is fitted with expansion gear on the Meyer principle, which can be adjusted by hand while the engine is running, to give the most economical point of cut-off for the work being done. The air pump is of the single acting vertical type, with gun metal liner, bucket, and head valves, the top part being bolted to the engine frame and the bottom to a base plate, which carries the condenser. Valves are provided on the eduction piping, so that the exhaust can be diverted into the atmosphere when required. A partially balanced flap valve is fitted on the delivery main to prevent water siphoning back through the pump when not working; and this valve, with an arrangement of steam ejector and cocks on the pump, admits of the latter being easily charged in a very short time. As will be seen from the illustration, the pumping engine is compact. Attention has been given to providing parts of ample size with efficient lubricators, etc., so that the engine will run for long periods with the minimum of trouble and expense.

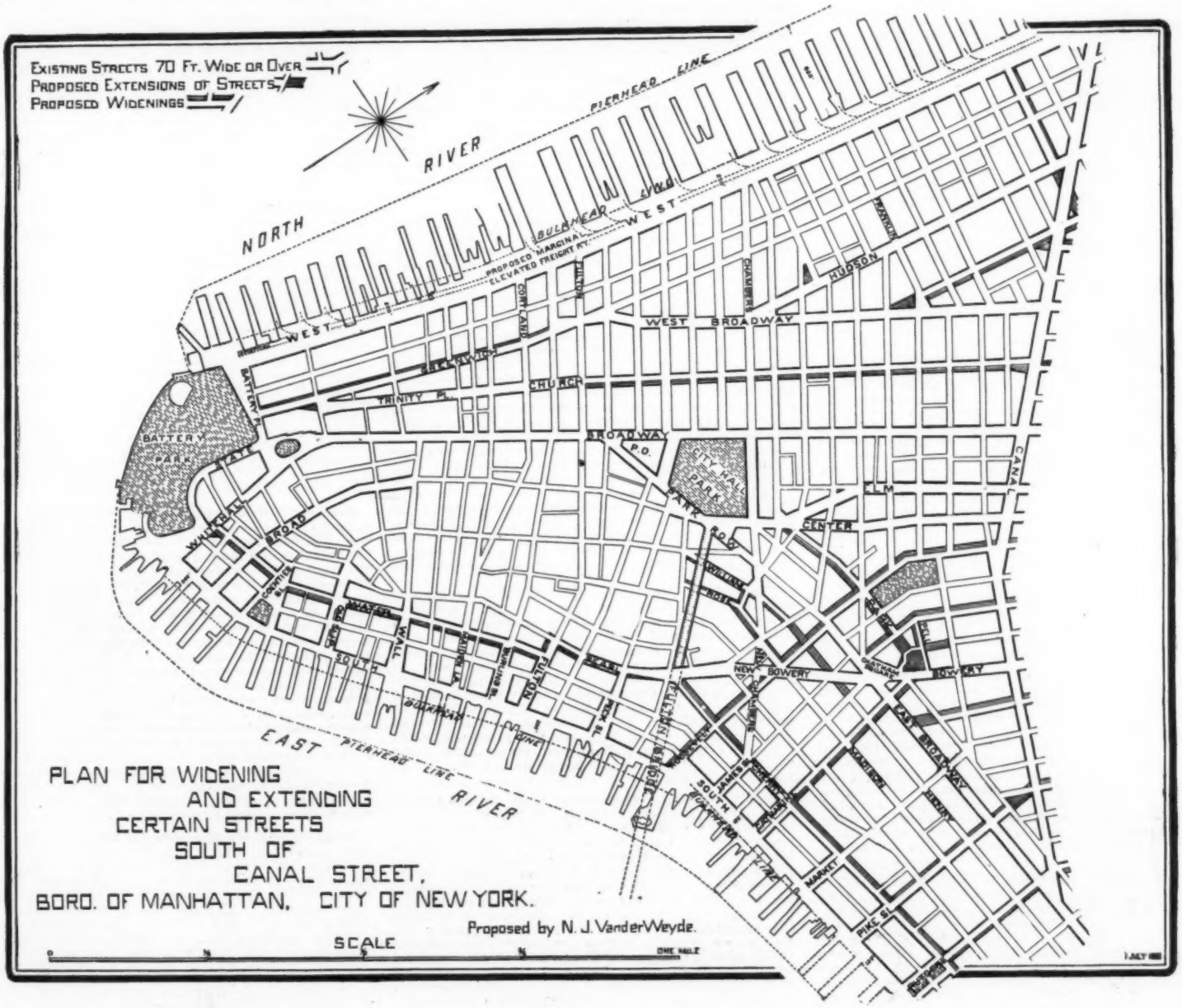
This machinery was made by Tangyes, Limited, of Birmingham, to the instructions of Mr. G. W. Risien, consulting engineer, and the order was placed with them because of the very satisfactory working of some slightly smaller plants they supplied two or three years ago. Since this plant was made orders for two similar pumping engines, but with larger engines than those illustrated, to deal with higher lifts, have been placed with Messrs. Tangyes, Limited.—The Engineer.

More than fifty high explosives are authorized to be manufactured in Great Britain, and are available for blasting. The latest is called fumelessite, because of the above great advantage. This results from the absence of nitrous or other noxious vapors on its combustion or explosion, owing to the fact that it does not contain nitroglycerine. It is a compound of nitrates of ammonium and potassium, oxide of iron, sulphur, and wood meal. It is the invention of Mr. Harold Boyd, an Australian. Its use is easy and safe. It does not require a detonator, nor will concussion or friction explode it. It rends and heaves, and does not have the awkward local concentrated smashing effect of dynamite. When unconfined it may be lighted by a flame, and then burns quietly away. It seems specially adapted for use in mines, where the fumes from other explosives form one of the chief drawbacks to their use.

NEW YORK STREET WIDENINGS AND EXTENSIONS.

Proposed by N. J. VANDER WEYDE, Civil Engineer.

IN the present number of the SUPPLEMENT we print the third map of Engineer Vander Weyde's plan for street widenings and extensions in lower Manhattan, which completes the series on proposed improvements south of Fourteenth Street. The Sixth Avenue extension, discussed last winter by the press of this city, suggested other extensions in what was once known as Greenwich Village. These were described and illustrated in SCIENTIFIC AMERICAN SUPPLEMENT, No. 1218. The new East River Bridge landing and the Chinatown question suggested widenings and extensions on the East side, for which see SUPPLEMENT, No. 1225; while the requirements of our shipping trade have brought forth the plan we publish in this issue, it also illustrates a proposed marginal Elevated Freight Railway, described in previous article.



With the widening of Greenwich Street, south of Dey, as a continuation of West Broadway and Hudson, which is here proposed, we will have a fairly wide street parallel with and close to our North River marginal street, from Battery Place to West Fourteenth Street, a great desideratum in times of unusual activity in the shipping trade. It is, incidentally, a full-sized outlet to the Trinity Place and Church Street widening, which had been left most incomplete and unfinished at both ends.

In consequence of the narrowness of the East River, between Corlaers Hook and South Ferry, the United States government will not consent to any further extension of the pierhead line; and, as a certain length of piers is required to meet the demands of steamship interests along this section of the river front, the established width of South Street has been made less than that of West Street, it being 200 feet wide west of the bridge and but 125 feet wide east of that point, West Street being 250 feet wide throughout its entire length. This should not be confused with the actual present width of South Street, which is but temporary and considerably less. In order to relieve possible congestion of our traffic on south side marginal street, it is here proposed to construct a continuous street 80 feet wide, parallel with and close to this section of the water front, by widening Water Street from Whitehall to Fulton, by cutting back the old United States Hotel and by widening Pearl Street from there to the bridge and Cherry Street throughout its entire length to Grand Street Ferry. This would also be of advantage locally to other traffic than that relating directly to shipping.

In the widening of Cherry Street we will clean out some of the vilest dens and most evil resorts on the lower East side, an object in itself worth working for. The proposal to clean out Chinatown and at the same time relieve Park Row traffic, mentioned in previous article, is acknowledged to have been incomplete. Fuller consideration of the subject decides that, besides cutting Elizabeth Street through to Pell and widening the latter, the block between Doyer Street and the Bowery, south of Pell Street, be made into a plaza, and that Park Street be widened to 80 feet and cut through from Mott to what might very appropriately be called Pell Square.

These plans have been favorably received by Commissioner James P. Keating, of the Department of Highways, and submitted by the Board of Public Improvements to their chief topographical engineer, Louis A. Risse; it is, therefore, to be hoped that something may be done under this general scheme of improving our city streets.

In the three articles and maps thus far published, the innovations suggested include about forty streets, aggregating 260 blocks, and amounting to ten miles of street widening and nearly half a mile of street extension. These have been designed for the local and general benefit of trade, and are hereby submitted to the final judgment of the public, the press, and the local authorities.

If only a part of this rather comprehensive scheme is favorably decided upon to begin with, much will have been gained, for every simplification thus far made in the extensive labyrinth born of New Amsterdam's cow paths and country lanes has paid for itself several times over in increased valuation of taxable property, besides being of direct benefit to the locality in which it has been made. Witness the extension of Hudson Street, in the first half of the present century, and the West Broadway improvement, lately completed; while the Worth Street, New Bowery, and New Chambers Street extensions are excellent illustrations of the benefits to be derived from cutting through and opening up the slums of a great city. Other examples might be cited, but it is hardly necessary; they can be seen on every side.

According to The Mechanical Engineer, the output of the American shipbuilding yards for the last fiscal year is announced as 1,429 vessels, and the aggregate tonnage as 320,876. With the exception of 1891, this is the largest year's production for 25 years.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Tariff on Agricultural Machines and Tools.—In reply to special instructions of May 13 from the Department, I have, says Consul-General Frank H. Mason, of Berlin, to report that the duty on agricultural implements, machines, and tools imported into Germany is specific and based upon the material of which the implement or machine is principally composed, modified again by the polish, painting, and finish, or outward decoration that has been applied.

These conditions, while theoretically simple, are, in practice, often exceedingly complicated, so that it is frequently impossible, even for an expert importer, to say positively what the duty on a new article will be until a sample has been imported and subjected to actual classification and appraisal by the customs officials.

In so far as the questions submitted by the Department can be answered from the imperial German tariff schedule, supplemented by the testimony of a leading importer of American machinery, such imports are classified for duty as follows, the rate given in marks, with equivalents in United States currency, being for 100 kilogrammes (220·46 pounds):

	Marks.		
(*a*) Machines and parts of wood or cast iron or both	3	=	$0 71
(*b*) Machines and parts of wrought iron and steel or both	5	=	1 19
(*c*) Machines and parts of other base metals or any other ordinary material	8	=	1 90

In classifying machinery, the principle holds that where a machine is composed of several different materials belonging to two of the above groups or designations, the machine as a whole shall be assessed under the class to which the greatest weight of its materials belongs, viz., wood and cast iron at 3 marks, wrought iron and steel at 5 marks, and brass, zinc, copper, and all other base metals and ordinary materials at 8 marks per 100 kilogrammes.

Thus, if a machine weighing 100 kilogrammes contains 40 kilogrammes of brass and copper, 30 kilogrammes of wrought iron, and 30 kilogrammes of cast iron, it would be assessed for duty under class *c* at 8 marks ($1.90) per 100 kilogrammes. If, on the other hand, it contains wood and cast iron weighing together more than all the other materials, it would be assessed under class *a* at 3 marks per 100 kilogrammes. In all cases the rate of duty is governed by the polish or outward finish of an article, and in this respect the German tariff is peculiar and leads to some curious decisions. Thus the rating of a fireproof safe is changed if, as is usual with safes of American manufacture, a picture is painted for decorative purposes on one of its panels. Thus, also plows and other agricultural implements, if rough and unpainted, are dutiable at 6 marks; but if polished, varnished, or painted, are assessed 10 marks ($2.38) per 100 kilogrammes. The duty on carriages is doubled when any portion of the vehicle is upholstered.

Tools of iron or steel alone or in combination with wood and not polished, varnished, or painted are dutiable as follows:

	Marks.		
(*a*) Rough, as anvils, shafting, etc., per 100 kilogrammes	3	=	$0 71
(*b*) Finished, as axes, hatchets, and mechanics' tools, per 100 kilogrammes	10	=	2 38
(*c*) Fine tools, polished and varnished, per 100 kilogrammes	24	=	5 71

The following machinery imported from countries which enjoy by treaty with Germany the privileges of the most favored nation (including the United States) may be imported in detached parts and assembled or set up in this country, and in this condition pay duty according to the rate pertaining to the chief material of composition, that is, greatest aggregate weight in the entire machine, as above explained: Flouring-mill machinery, electrical, cotton-spinning and weaving, steam engines and boilers, paper-mill equipments, machine tools, turbines, woolen spinning and weaving, pumps, ventilators, blowing machinery, steam hammers and rollers, shearing, punching, and boring machines, etc.

How to Extend Our Trade in South America.—Consul Hill sends from Santos, under date of April 18, 1899, tables showing the trade of the United States with the various South American countries during the last ten years. There has been during the decade, comments Mr. Hill, a steady decline in our imports from South America in values and quantities; for, with the single exception of coffee, the staples constituting our imports from that section (India rubber, wool, sugar, hides, etc.) are higher in price to-day than they were ten years ago. Coffee, which has greatly increased in quantity, has fallen tremendously in value. Rio Standard No. 7 sold July 1, 1893, at 16½ cents; December 1, 1894, at 15¾ cents; January 5, 1895, at 16 cents; January 4, 1896, at 14¾ cents; January 2, 1897, at 10¼ cents; December 4, 1897, at 6¾ cents; the last named figure being about the prevailing price at New York at the present time.

The most notable expansion in our export trade during the last ten years, adds the consul, has been with Europe; but there has been a greater increase with every part of the world than with South America. He continues:

The United States should employ the agencies adopted by European nations in attaining their supremacy in these markets, viz., steamships under our own flag, banks under our own control, and business houses under distinctively American management. Once we are placed upon terms of equality in these particulars, our merchants can be left to their own initiative. No one acquainted with their resourceful, enterprising, and adaptable character need doubt that, with our present capacity to manufacture largely and cheaply, we shall gradually assume our proper place as a competitor in South American trade.

Consul Hill mentions the good effects of the cruise of the "Wilmington" to the upper reaches of the Amazon. He says:

In addition to the labor of exploration that formed such an important object of the cruise, the display of a modern steel vessel so perfectly adapted to river work as the "Wilmington" is a fit exhibition of the capability and preparedness of our domestic designers, steel plants, shipyards, and ordnance works to turn out products equal to the best. Nothing that comes within the actual purview of foreign folk, whether native or merely domiciled denizens, is so emblematic of a nation's industrial power or weakness as the government vessels that fly its flag in foreign parts.

During the years succeeding Admiral Walker's visit of congratulation to Brazil in 1890, he continues, when the vessels of our new navy took the place upon this coast of the "Tallapoosa," "Essex," and "Yantic" types—which were neither ornamental nor useful and were in constant danger of being run down by nonmilitant coal barges—the increased respect commanded by the appearance of our vessels has been, I believe, a real and constant, though inappreciable, commercial factor.

Canadian Canal Problem.—The Province of Ontario is becoming alarmed over the seeming decadence of the Welland Canal, and strong pleas are being made for harbor improvements at Port Colborne, its Lake Erie terminal. It is urged that the lack of harbor facilities at that port is largely responsible for the loss in traffic. The harbor is in the same condition that it was seventeen years ago, when the Welland Canal was opened. The lake vessels now require such a depth of water that none of the larger class attempt to enter Port Colborne.

The Welland Canal is 26¾ miles in length, connecting Lake Erie and Lake Ontario by cutting through the narrow Niagara peninsula. There is a fall of 326¾ feet in the 27 miles of canal, necessitating twenty-six locks. These locks are 270 feet in length by 45 feet in width. The canal has a depth of 14 feet, and when it was opened it was supposed that provision had been made for the largest lake craft. But the deep Sault Ste. Marie Canal has permitted the construction of such immense freight carriers that most of the vessels which could navigate the Welland Canal have been driven out of the carrying trade.

When the vessels became too large to enter the Welland Canal, lightering was resorted to. The Grand Trunk Railway built a branch line parallel with the canal. Enough of the cargo was transferred to the railroad to enable the vessel to pass through the canal, and then the cargo was taken on again at the other terminal. This expedient has worked fairly well until recently; but in the meantime the lake vessels have been growing in size each year, and with each increase came lower freight rates, driving the smaller vessels out of competition. Steamers with 200,000 bushels capacity now control the grain-carrying trade, and these cannot enter Port Colborne Harbor. The vessels that can enter are growing less in number each season, and soon even the expedient of lightering vessels will not suffice to bring traffic to the canal.

While the government admits the necessity of a better harbor, it seems unwilling to take immediate steps toward providing one. It is urged that this will prove of only temporary value unless the canal is enlarged as well; and if the canal is enlarged so as to admit the largest lake craft, there would still be heavy expenditures required on the St. Lawrence route, which does not even have a 14-foot channel for its entire length, although that depth is expected to be secured this season.

The Welland Canal, up to date, has cost the government $24,173,352. Its best year in tonnage was 1893, when 1,294,823 tons of grain and merchandise passed through it east and west. Since then, the decline in grain shipments has been especially marked, although the grain traffic on the lakes increases every year. In 1893, the grain that passed down the Welland was about 16 per cent. of the grain receipts at Buffalo; in 1898, it was about 9 per cent., or a loss of 43 per cent. as compared with Buffalo. The grain that passed down the Welland last year was less than five years ago, while the grain receipts at Buffalo were nearly three times what they were ten years ago.—Harlan W. Brush, Consul at Clifton.

Direct Steamship Connection with Syria.—Consul Ravndal writes from Beirut, May 26, 1899:

American manufacturers and exporters, as well as importers, will be interested in learning that Barber & Company, Produce Exchange, New York city, will dispatch a steamer direct for Beirut on the 10th proximo, which, after discharging at this port, will receive cargo for New York, touching on the way home at Alexandria. According to the information in my possession, it is more than likely that this steamship agency will have steamers calling at Beirut regularly once every six weeks, and, if this proves true, a lively interchange of goods may be expected. The consular representatives of the United States in the Levant have for years been working for direct transportation facilities, as essential to the development of the United States trade with countries of the eastern Mediterranean. Now that this seems to be realized, all concerned should encourage the promoters, in order to make the service permanent and a success. Steps are now being taken toward the establishment of a sample room in Bierut, to facilitate the introduction of American goods.

Pearl Fishing in Venezuela.—Consul Plumacher sends from Maracaibo, May 2, 1899, copy of a recent decree of the Department of Agriculture, Industry, and Commerce of Venezuela, according to which the North American Sucking Company is to be allowed to examine the pearl beds existing on the coast. In former years, says the consul, the pearl fisheries on the Spanish Main were celebrated, and the products were valuable. Fishing with rakes is prohibited. A report is to be made to the government, and the commissioner, Mr. Garcia, is to receive 600 bolivars ($115.80) per month.

Mechanical Power in Germany.—Under date of Chemnitz, May 20, 1899, Consul Monaghan transmits the following statistics relative to horse power machinery and engines in Germany, and the opportunity for the increase of sales of American makes:

The employment of motors in industries is rapidly increasing in Germany. From 1875 to the present time the number of concerns using motor power has increased seven-fold, the horse power three-fold or four-fold. According to the census of 1895, 3,421,194 horse power was employed. Of this power, 2,715,078 was put down to steam, 629,065 to water. The 3,421,194 horse power represents only the real power put forth, not the indicated or possible power. It seldom happens that an engine or motor is used at anything like its indicated capacity. The power used in agricultural pursuits, railroad, river, harbor, and coast transportation, etc., also the great central stations that supply power to other concerns, is not taken into account in the foregoing. The German railroads employed in 1895, 16,377 locomotives (16,107 on the wide-gage roads and 270 on narrow gage). Giving the wide-gage-road engines an average of 450 horse power, and the narrow-gage 150, we get for the empire's locomotives 7,288,000 horse power. Among the farmers of Germany (in 1894–95) 259,364 farms used steam thrashers, 1,696 steam plows, and 26,000 milk centrifugals with power. Ocean steamers (1,061) had in 1895, 801,750 horse power; river, harbor and coast steamers (1,530) had 171,360 horse power. These figures are all for 1895, and there has been a constant increase since. I am not sure that there is not a field here for our better class high-grade engines. The tendency everywhere is toward steam, water, electrical, and gas powers. Engines, if cheap enough and good enough, ought to go as well here as with us. The demand is not decreasing. Agricultural machines, most of which had their origin in our country, are imitated; how successfully, only one familiar with the machines can say. If we work half as hard as do Germans, we can conquer markets in Russia, the East, South Africa, Australia, etc., where our machines are almost sure to succeed, price for price, against all others.

Commercial Work of French Consuls.—The following, dated Lyons, April 29, 1899, has been received from Consul Covert:

Among the many efforts made to increase the trade of France in the Orient is one by which the consuls are to be brought into direct communication with the business men of their country. In pursuance of this plan, the Cousul-General at Calcutta will hold a reception to meet the business men of Paris at the Ministry of Foreign Affairs. The announcement is made that "he will place himself at the disposition of persons who wish to consider the possible openings for French trade in British India, especially for rails, nails, automobiles, petroleum, velocipedes, textiles, silks, laces, woolens, cottons, jewelry, silverware, watches, clocks, machinery for flour mills, photographic apparatus, and Paris-made articles." The consul at Calcutta will visit several industrial centers in France, for the purpose of discussing the same matters with business classes.

Demand for Locomotives in Tunis.—Consul Skinner writes from Marseilles, June 8, 1899:

I learn to-day from Tunis that the Compagnie des Phosphates et du Chemin de Fer de Gafsa, a corporation engaged in extensive enterprises in that protectorate, is in the market for all sorts of rolling stock, including locomotives, and that proposals have already been invited in England. I think that it is not too late for American manufacturers to compete for this order if prompt action is taken. The address of the company is 60 rue de la Victoire, Paris, and for cabling purposes it may be addressed as the "Compagnie Gafsa."

Breeding of Reindeer in Norway.—Under date of May 4, 1899, Consul Nelson, of Bergen, reports that a company has been formed in Telemarken, eastern Norway, for breeding and raising reindeer on a large scale. At the head of this undertaking is Nils Bohnen, one of the teachers in the people's high school, and for a time he will personally superintend the industry. The company has already bought 2,400 deer for 28,000 kroner ($7,504), and by degrees they will increase the herd to between 3,000 and 4,000 deer. When this number has been reached, the company will be enabled to kill about 1,000 deer every year without diminishing the herd. When slaughtered a deer is worth about 20 kroner ($7.36), and there are good markets for this meat, especially in France and Belgium. The company also hopes to induce England to purchase it. In order to prevent the glutting of the market during the winter season, a canning plant will be attached to the farm for the purpose of preserving the meat. This hermetic factory will also can red char (a species of small salmon) and ptarmigan. The company controls 50 to 60 square miles of wild mountain land.

Demand for Dairy Machinery in Belgium.—Consul Le Bert writes from Ghent, May 19, 1899:

I have this day received from Mr. A. Heynssens, Rue Haut Port 12–14, a letter asking the names and addresses of important firms in the United States manufacturing dairy machinery, such as churns, separators, butter workers, dairy articles, refrigerators, cheese making machines, etc. He desires firms not as yet represented in Belgium and asks that catalogues and circulars, with conditions of sale, be addressed directly to his firm. This house is one of the oldest and largest of the provinces of East and West Flanders handling the line of goods mentioned. Upon inquiry, I learn that none of these articles are manufactured in Belgium.

The importations to both Flanders are chiefly from England and Denmark. Considering the vast dairy industry of the Flanders and our improved apparatus, there should be, with proper representation, a wide field for our manufacturers of dairy machinery and utensils.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 472. July 10.—Tramways in Milan—Trade in the Argentine Republic: Imports from United States.

No. 473. July 11.—United States-Brazilian Trade—*How to Extend our Trade in South America—*Locomotives in Germany—Art Exhibition in Antwerp.

No. 474. July 12.—Federal Movement in Australia—Petroleum in Borneo—New Fuel in Belgium—Sale of Specimens of Persian Art.

No. 475. July 13.—Legal Status of Foreign Corporation in Russia.

No. 476. July 14.—*German Tariffs on Agricultural Machines and Tools—Harbor Improvements at Victoria—Patent Medicines in Portugal—Merchants in Athens—Municipal Taxes in Madagascar—Mining Law of the Dutch East Indies.

No. 477. July 15.—German Exports of Soap and Perfumery—*Electric Industry in Japan—Colonial Office in France—Leather Industry in Russia—Japanese Tea Exports, 1898-99.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

MISCELLANEOUS NOTES AND RECEIPTS.

Dyeing Without Pigments.—Under this seemingly paradoxical caption the last April number of the newly started Paris journal, Revue Générale de Chimie Pure et Appliquée, publishes a highly interesting article by the chemist, Olivier Glotin. This article starts from the physical standpoint that colors can be produced on the one hand by dyestuffs, and on the other hand by "interference." Under this name all those color phenomena are classed in natural philosophy which are perceived when luminous rays penetrate very thin layers of a body or are reflected by thin lamels. A sufficiently known example of this kind is furnished by the soap bubble, the wings of an opalescent butterfly, Newton's disk, etc. Such thin lamellæ may also be produced artificially in a large quantity by pouring a certain collodion solution over the surface of a body, e. g., a sheet of paper. Thus a variegated paper may easily be produced, which, however, comes pretty dear, and whose colors are entirely subject to chance. Professor Charles Henry, director of the laboratory for physiology of the organs of sense in the Sorbonne, has succeeded to solve the problem, "How can resistive, lasting colorings on paper of certain opalescence be obtained without the use of dyestuffs?" Professor Henry employs especially a solution of turpentine resin and dammar resin, as well as asphalt, in benzine and other hydro-carbons not soluble in water, and thereby obtains very thin lamels, whose colorings can be varied, changed or intensified at will. The envelopment of the little lamels is about forty times that of the soap bubble. A sample adjoined to the work of colored paper produced in this manner (an imitation of a snake skin glittering in metallic colors) shows the great perfection of the Henry process.

Impregnating Sail Cloth.—First, prepare a zinc soap by entirely dissolving 56 parts of soft soap in 125 to 150 parts of water. To the boiling liquid add, with constant stirring, 28 to 33 parts of zinc vitriol (white vitriol). The zinc soap floats on top and forms, after cooling, a hard white mass, which is taken out. In order to clean it of admixed carbonic alkali, it must be remelted in boiling fresh water. Next place 232·5 parts of raw linseed oil (free from mucus) in a kettle with 2·5 parts of best potash and 5 parts of water. This mass is boiled until it has become white and opaque and forms a liquid, soap-like compound. Now, add sugar of lead, 1·25; litharge, 1; red lead, 2; and brown resin, 10·5. The whole is boiled together about one hour, the temperature not being allowed to exceed 100° C., and stirring well from time to time. After this add 15 parts of zinc soap and stir the whole until the metal soap has combined with the oil, the temperature not exceeding 100° C. When the mixture is complete, add a solution of caoutchouc, 1·2, and oil turpentine, 8·56, which must be well incorporated by stirring. The material is first coated on one side by means of a brush with this composition, which must have a temperature of 70° C. Thereupon hang it up to dry, then apply a second layer of composition possessing the same temperature, which is likewise allowed to dry. The fiber is now filled out, so that the canvas is waterproof.—Farben Zeitung.

Dull Varnish for Trunks.—

Sandarac	1·0 kilos.
Orange shellac	2·5 "
Turpentine	0·2 "
Alcohol (95 per cent.)	10·0 liters.
Fine American lampblack	0·6 kilo.

Dissolve the sandarac, shellac and turpentine in the alcohol, cold or hot, stir the lampblack in, and grind uniformly in the paint mill.—Seifensieder Zeitung.

Paint for Toys, etc.—A harmless red color for toys is obtained by dissolving alkanna bark in alcohol or benzine. A coating of stannic chloride dyes the red coat crimson, a soda coating changes it into blue, one of acetic acid into bluish gray. If diluted ammonia is allowed to act on it, a green color is produced; a sublimate solution changes it into salmon color. The latter two colorings are poisonous, hence cannot be employed for toys.—Deutsche Malerzeitung.

New Use of Cassel Brown.—H. Borntraeger, Frankfort on the Main, says: According to my experiments, a concentrated solution of sodium humate constitutes a very handsome, sepia-like drawing ink, which can be modified in various forms. If writing is done with sodium humate alone, the quickly drying lines may at any time be washed off again, thus giving an opportunity of using the paper over again, which no other ink affords. If, however, the dried writing is bathed in diluted acid, a tracing of pure humic acid results, which cannot be removed with water and acids, but only with lyes or soaps. If one goes still further and bathes the first writing (sodium humate) in a freshly prepared green vitriol solution, washing out with water and drying again, a writing of ferrous humate is obtained, which can be removed neither with water nor with acids or lyes. Only by treatment with acids and then with lyes will it disappear. Hence it is an excellent ink for documents and designs, and, naturally, for marking linen and for dyeing. I have left postal cards thus prepared lie in water, and even by rubbing the letters could not be removed again. Since all humic salts look alike, any other metallic salt may be employed, e. g., calcium chloride, blue vitriol, lead acetate, etc. A goose quill is best adapted for writing with the metallic solution, afterward bathing with strong sodium humate solution.—Farben Zeitung.

Production of Consistent Mineral Oils.—

1.	Mineral oil	100 kilogrammes.
	Linseed oil	25 "
	Ground nut oil	25 "
	Lime	10 "
2.	Mineral oil	100 "
	Resin oil	100 "
	Rape seed oil	50 "
	Linseed oil	75 "
	Lime	25 "
3.	Mineral oil	100 "
	Linseed oil	30 "
	Earth nut oil	30 "
	Barytes	10 "
4.	Mineral oil	100 "
	Rape oil	40 "
	Cocoanut oil	10 "
	Lime	10 "
5.	Mineral oil	100 "
	Rape oil	30 "
	Earth nut oil	30 "
	Lime	15 "

—Farben Zeitung.

SELECTED FORMULÆ.

Baking Powder Formulas.—

(1)	Pure cream of tartar	1 pound.
	Sodium bicarbonate	1 ounce.
	Starch	8 ounces.
(2)	Pure cream of tartar	24 "
	Sodium bicarbonate	12 "
	Milk sugar	4 "
	Starch	4 "
(3)	Pure cream of tartar	23 "
	Sodium bicarbonate	10 "
	Tartaric acid	1 "
	Starch or flour	16 "

—Bulletin of Pharmacy.

To Whiten the Hands.—Lanoline, 30; glycerin, 20; borax, 10; eucalyptol, 2; essential oil of almonds, 1. The Quart. Therap. Rev. recommends a mixture of these ingredients to be rubbed on the hands, which are then covered with gloves during the night.—Deutsch. Am. Apoth. Ztg., 19, 157.

Preparations for Chilblains.—(1) For broken chilblains: Zinc sozoiodolate, 1; vaseline, 10; m. f. ungt. (2) Resorcin, ichthyol, tannic acid, of each, 2; distilled water, 10. D.S.: To be shaken up before use and rubbed into the affected parts. For frost bites: Pine needles are boiled for two to three hours, the decoction strained, and the frozen limbs bathed in it three times per diem. The bath should be lukewarm and last ten to fifteen minutes.—Deutsch. Am. Apoth. Ztg., 19, 157.

Liquid Moth Destroyers.—

		Parts.
(1)	Naphthalin	10
	Carbolic acid	10
	Camphor	5
	Alcohol	500
	Spirit of lemon	5
	Oil of thyme	2
	Oil of lavender	2
	Oil of savine	2

This may be used by sprinkling, or better still, by means of an atomizer.

		Parts.
(2)	Oil of patchouli	1
	Nitrobenzene	9
	Naphthalin	20
	Carbolic acid	20
	Camphor	50
	Oil of turpentine	50
	Alcohol	850

Mix, let stand for several days, and filter.

		Parts.
(3)	Oil of patchouli	1
	Oil of cloves	5
	Oil of bergamot	5
	Carbolic acid	10
	Alcohol	150

(4)	Alcohol	40 fluid ounces.
	Tincture of capsicum	5 " "
	Naphthalin	1 ounce.
	Carbolic acid	1 "
	Menthol	½ "
	Oil of lemon grass	½ fluid ounce.

Use in the form of a spray by means of an atomizer, where the moths frequent.—Merck's Report.

Solid Perfumes.—"Solid perfumes" are composed of solid paraffin, with which the essential oils of any particular bouquet have been blended while liquid, in the proportion of ½ to 1 drachm of the perfume to 1 ounce of paraffin. To make these perfumes melt the paraffin on a water bath, and allow to cool without stirring and without removing from the water bath; when the wax becomes creamy, stir in the perfumes and pour the mass to the depth of ⅛ to ¼ inch in a tin previously brushed with a solution of soap (soap liniment). When the mass sets, score the surface to the size of cakes desired. The following from Pharmaceutical Formulas are said to be suited for putting up as specialties with fancy names:

(1)	Paraffin	4 ounces.
	Oil of lavender	2 drachms.
	Oil of bergamot	2 "
	Oil of cloves	1 "
	Oil of rose geranium	½ "
	Vanillin	8 grains.
	Almond oil	1 drachm.

Triturate the vanillin with the almond oil, add the oils, and shake well before adding to the paraffin.

(2)	Paraffin	4 ounces.
	Oil of linaloe	2 drachms.
	Heliotropin	½ "
	Oil of bergamot	½ "
	Oil of lemon	½ "
	Almond oil	1 "

Mix as above.

(3)	Paraffin	4 ounces.
	Oil of ylang-ylang	2 drachms.
	Oil of cloves	1 "
	Oil of sandalwood	½ "
	Coumarin	20 grains.
	Essence musk	½ drachm.
	Almond oil	1 "

—Pharmaceutical Era.

Tooth Soap.—Cassini, in The Bulletin Commerciel, gives the following:

Castile soap, in powder	200 parts.
Glycerin	5 "
Salicylic acid	5 "
Oil of anise	10 "
Carmine, sufficient.	
Eosin, sufficient.	

Rub up the carmine and eosin with a small amount of the powdered soap, then add the rest of the soap, and the oil, and rub well together. Dissolve the acid in glycerin, add the solution, under constant rubbing. Finally, add sufficient glycerin to make a paste of the desired consistency.

MISCELLANEOUS NOTES.

London is the chief center of business in Zanzibar clove oil, but new markets have been formed in Amsterdam and Rotterdam. Ten thousand bales of cloves have been laid in, and a serious attempt is being made to transfer the trade to Holland. In quinine and other oils and drugs English chemical manufacturers are already compelled to visit Dutch markets for supplies.

Continuing experiments begun by his master, the late Camille Dareste, Mr. Rabaut finds that eggs exposed for half an hour in a freezing mixture at −15° C. are not killed. Lasting perturbations are induced, and after warming (quickly or slowly) most of the eggs show in three days a proliferating blastoderm spreading over the yolk, but without trace of embryonic differentiation. Some showed abnormal embryos, and a very few—proving the individuality of the egg—were normal.—Natural Science.

In a number of glass mirrors of the third and fourth centuries, examined by M. Berthelot, the glass was coated with a metallic substance and with a layer of whitish material. The metal proved to be lead, with no trace of gold, silver, copper, tin, antimony, or mercury, and no sign of organic substance was present. It was thus shown that no extraneous material was used to cement the lead to the glass. The mirrors appeared to have been cut from hollow blown glass globes, and it is possible that before the globe was cut the molten lead had been poured into the interior, and had adhered to the previously warmed glass. The whitish layer consisted of lead carbonate and lead oxide formed by the oxidation of the lead coating and calcium carbonate, which had been deposited from the water of the district in which the mirrors were found.

The word porphyry means purple, and is the name originally applied to the purple-colored rock used in Egypt for making monuments, etc. As applied to rocks now, it has only a structural significance. As now understood, porphyry is any rock in which distinct crystals of any mineral occur which are larger than the grains or crystals of the ground mass in which they occur. The ground mass may be very fine in texture or may be quite coarse. A fine-grained, dark-colored rock in which occur white crystals of feldspar is porphyry; a fairly coarse granite in which occur crystals of feldspar an inch or two in length is also porphyry. There is also quartz-porphyry, hornblende porphyry, feldspar-porphyry, etc. Porphyrite is a name applied to basic rocks having a porphyritic structure, as diabase-porphyrite, diorite-porphyrite, etc.—Scientific and Mining Press.

According to The London Chemical Trade Journal, the high prices for cement ruling at the end of 1897 were maintained during the year 1898; even at the close of the building season the demand was very considerable. The demand in Germany was caused by a new law which came into force in that country in 1898, by which every German town with a population of over 10,000 must be drained. Thus Germany actually became a market for Russian cement, whereas in former years some 15,000 barrels of cement were imported annually from Germany to Russia. The German syndicate of cement works on the one side, and the cement works in Russian Poland on the other, have now entered into an agreement by which they mutually bind themselves not to export any cement during 1899. Should this arrangement be found advantageous for both sides, it will be further prolonged. Of the new cement works which are building in Poland, only one has actually started operations. The total production of cement in Poland is about 8,000,000 poods, or 146,000 short tons.

Goldschmidt, a German investigator, obtains high temperature by the oxidation of aluminum, which he effects by heating a powdered mixture of the metal with some common oxide. The heat obtained, together with the reducing action of the aluminum, enables metals to be smelted by this method. Among other practical applications is the following, quoted from The Chemical News: "A rivet, such as is employed in bridge making, is embedded in a mixture of oxide of iron, sand, and aluminum powder. The whole is plunged in sand contained in a wooden box. On top of the aluminum mixture, which must just emerge from the sand in the box, we place a small lump of a mixture of aluminum powder and an easily reduced oxide, in which is fixed the end of a short piece of magnesium ribbon. The reaction is started by lighting the free end of the magnesium, and we then immediately place more sand on the top of the mixture, so that as little heat as possible may be lost. If at the end of a few moments we empty out the contents of the box the rivet will be found to be quite red hot and ready to be forged. Working in an analogous manner, we can weld together steel tubes, and the expense will not be more than twopence. We can even fuse together two bars of soft steel." According to the inventor the temperature obtained under these conditions may be higher than that realized in the electric furnace.

Reports of recent and successful experiments in improving road surfaces by sprinkling them with oil increase the surprise at the unsatisfactory termination recently of like experiments on the roadways in Boston's parks. These good reports come from California and Florida. In the former State supervisors of Los Angeles County recently examined several sections which had been sprinkled with oil, and found them in excellent condition. A mile stretch at Alhambra, sprinkled once a year ago, had no dust, and riding over it is described as "like riding on rubber." In Florida the experiments were in Duval County, where roads made of shell rock had been greatly damaged by heavy travel, which ground the surface fine, the wind blowing it away. A section of new road of Volusia shell at Jacksonville was sprinkled with oil six weeks ago. At first there was a noticeable odor, but this soon passed away. The surface was united in a solid mass, which became more compact with travel; the road was smooth and crowned, and rain and moisture did not penetrate, but ran off, forming no mud. Sun heat had no effect on it, and where the oil was applied less thickly the surface was slightly ground up, but remained on top without blowing away. It is now proposed to cover one mile of road with oil, at a cost of $278 for twenty-five foot width.—New York Evening Post.

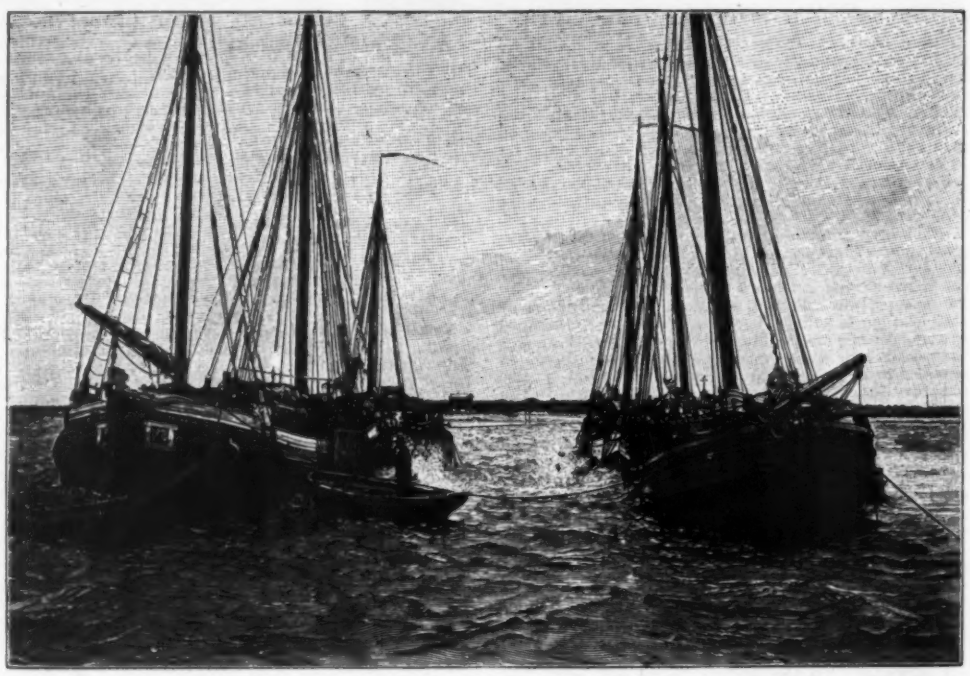
THE PRESERVATION OF THE DUNE OF HELGOLAND.

NORTH Sea voyagers who have seen the red rocks of the little island of Helgoland rise up out of the waves probably never suspected that here there was once a huge mass of rock many hundred meters in height, the base of which was fifty or sixty times greater than the present island, a fact proved by the geological structure of the island, and by the tectonic formation of the cliffs that still remain. The island, as may be seen from its steep walls, is built up of stratified or sedimentary rock. The horizontal strata originally formed on the bed of the sea by the separation of deposits became faulted or wrinkled, after they had already petrified by the sinking of the earth's crust, which had to adapt itself to the changed form of the cooled interior. Helgoland is part of such a wrinkle in the aged countenance of Mother Earth. Battling for thousands of years against the ceaseless attacks of the sea and perchance of the melting glaciers of the diluvial epoch, the island contracted to the small remnant which we now see. During this work of destruction the parts which had crumbled away, moved by the currents and the waves, were deposited upon the storm protected side of the island; and thus were formed the lowland and the dune.

Lowland and dune, even at the beginning of the last century, were still connected by a wall of rubble, likewise composed of eroded island rock. Wall and dune were protected from the northeasterly storms by a gypsum-rock rising 1⅛ kilometers (nearly a mile) from the dune and running in a northwest direction. After the islanders had demolished the greater part of the rock in order to sell the gypsum, the last remnant was destroyed by the sea; and wall and dune lost their protection. First the wall broke in two, so that island and dune were parted. Then the dune, given up to the storms, dwindled away year by year. For a long time it was left to its fate; until its true value was recognized, and in 1826 a seaside resort was there established. The forces of the islanders were, however, not strong enough successfully to combat those of nature; and the "practical" Englishmen saw no reason for assisting them, as the island brought no returns.

When Helgoland was ceded to Germany, the present ruler endeavored to retrieve what had been lost, and by energetic measures to preserve the little sandy isle from certain destruction. For this purpose a system of protection has been devised by Oberbaudirektor Franzius of Bremen, which during storms is intended to break the force of the waves, and during fair weather to collect the lightly drifting sands and convey them to the dune. The system employs eight radiating breakwaters connected by transverse dikes. The breakwaters are 1,100 meters long (0·662 mile), and even at low tide are submerged for the greater part of their length. They consist almost entirely of fascines and stones. Those parts of the breakwater and transverse dikes which are composed of fascines can be cheaply and readily built on dry land; but the making of the submerged portions is more costly and difficult.

In constructing these submerged portions, mattresses are woven on the most level and deep part of the beach. The mattresses are 40 to 65 m. (131·20 to 196·80 feet) long, 10 m. (32·80 feet) wide, 70 cm. (2¼ feet) thick, are held together by cables and ropes, and are composed of fascines systematically disposed in layers and bound together as tightly as possible. These mattresses are left on the beach, and are floated by the incoming tide. They are then towed out to their destination, and are loaded with stone carried by four vessels anchored there for that purpose. The mattresses are thus gradually sunk and form a solid, resistant structure on the bed of the sea. In this manner the laden mattresses are placed next to one another until the desired length of the breakwater has been attained. One of our illustrations shows part of a completed breakwater rising out of the water at low tide.—Illustrirte Zeitung.



SINKING A MATTRESS.

PORTION OF A BREAKWATER EXPOSED AT LOW TIDE.

WEAVING A MATTRESS ON THE BEACH.

PROVISIONING AN ATLANTIC LINER.

THE "provisioning" of an Atlantic liner has often been mentioned in a vague sort of way; but The New York Sun gives a long article on the subject from which we extract the following, premising that the term "provisioning" includes other things than articles of food. The Sun is speaking of such a vessel as the "St. Louis," and says that a ship like one of the new liners frequently carries 1,500 persons across the ocean. There is probably no hotel in the world that frequently has any such number of guests for a week at a time. Almost every article that can be imagined to be of use in a hotel or private house is included in the list of supplies. The list ranges from beer mallets to pianos, from cheese scoops to "paste jiggers," from dish-washing machines to dice boxes, from dark lanterns to costly stationery, and from a printing press to a fire-proof safe. When it comes to food and drink, the ingenuity of the port steward of the line and the steward of the ship is exercised. It is customary on all ocean steamships for the steward to keep an accurate account of all articles used from day to day. When a ship reaches port the steward has a report in tabular form showing the amount and kinds of food used every day, and also showing how much there is in store. A day or two before the ship leaves port again the number of passengers that will probably sail on the ship is figured up and the ship's steward makes requisition on the port steward for supplies for the trip. Few persons realize the variety of the food supplies required. For example, no

less than fifteen kinds of cheese are used. Fish in fully a hundred grades and forms is stowed away. Here is part of what is required in the way of supplies when a ship like the "St. Louis" is crowded: 25,000 pounds to 30,000 pounds of beef, 5,000 pounds of mutton, 2,600 pounds of veal, pork and corned beef; 8,000 pounds of sausage, tripe, liver, calves' head, calves' feet, sweetbreads and kidneys; 2,000 pounds of fresh fish, 10,000 clams and oysters, 250 tins of preserved fruit, 200 tins of jam and marmalade, 100 large bottles of pickles and sauces, 500 pounds of coffee, 250 pounds of tea, 250 pounds of potted fish, 300 fresh lobsters, 3,000 pounds of moist sugar, 600 pounds of lump sugar, 500 quarts of ice cream, 3,000 pounds of butter of various grades, 16 tons of potatoes, 5 tons of other vegetables, 15,000 eggs, 1,000 chickens and ducks, and 2,000 birds of different kinds. Lard by the ton is used, and frequently as many as 140 barrels of flour are consumed.

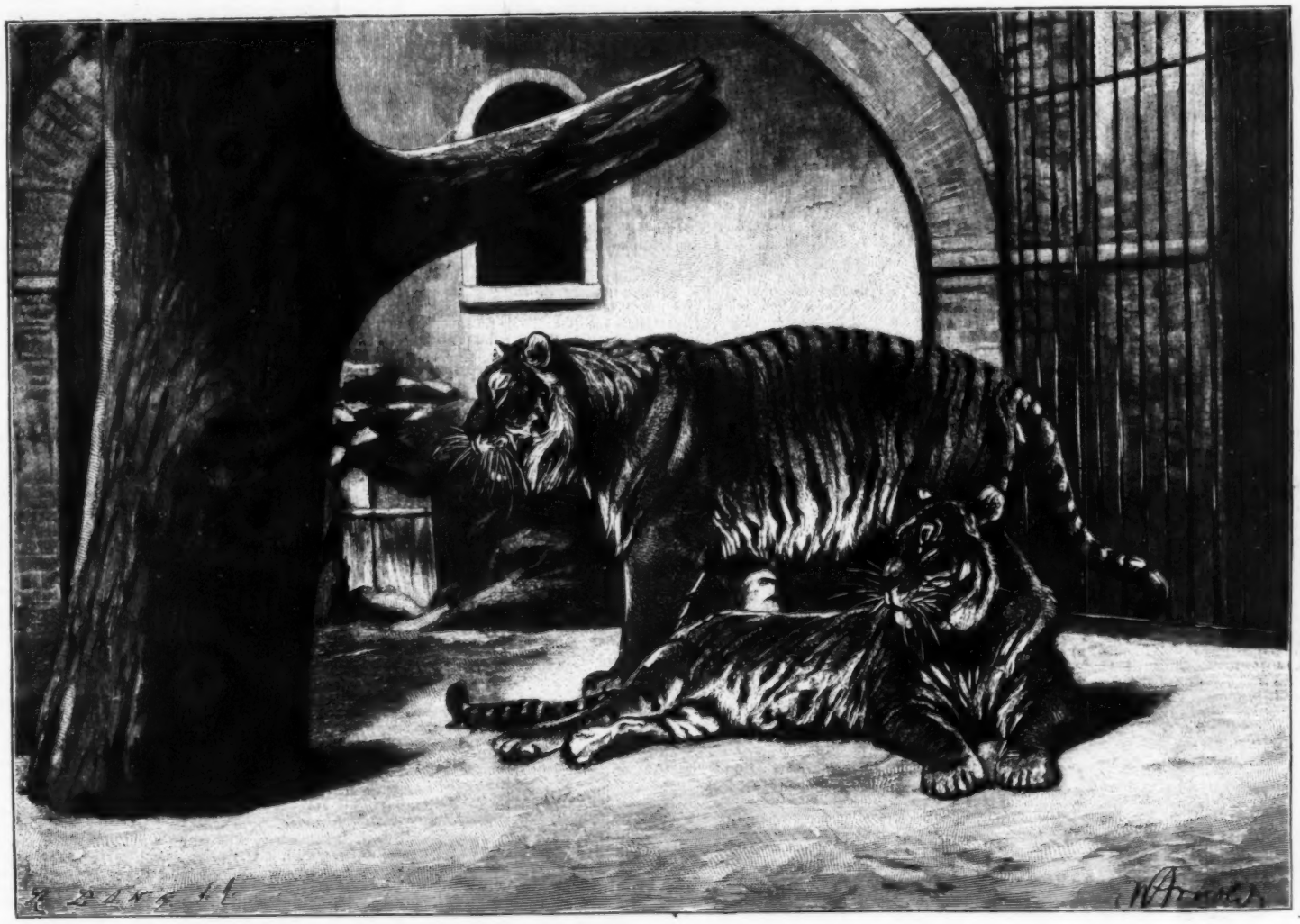
Several years ago there was published the record of the amount of food consumed on the entire Cunard fleet for one year. The record is probably as large, but not much larger, at the present time. In one year it was shown that the passengers on the Cunard boats consumed these items of food: 4,656 sheep, 1,800 lambs, 2,474 oxen, the total being equivalent to more than 2,000,000 pounds of fresh meat. There were also used 53 tons of ham, 20 tons of bacon, 25,000 chickens, 4,500 ducks, 2,000 turkeys, and 2,000 geese. The number of eggs used in one year on the fleet was nearly 850,000. The supply of tea amounted to 21,000 pounds. The amount of coffee used was nearly 72,000 pounds. The pounds of sugar consumed reached nearly 300,000. In the matter of spices the figures reached 30,000 pounds of mustard and 35,000 pounds of pepper. There were also used more than 7,000 bottles of pickles, 8,000 tins of sardines, 30,000 pounds of salt fish, 4,000 jars of jam, and 15,000 tins of marmalade. The consumption of raisins, currants and figs amounted to about 22 tons. In the consumption of pearl barley 15 tons were used, and other figures follow: Split peas, 18 tons; rice, 17 tons; oatmeal, 34 tons; flour, 460 tons; salt, 33 tons. There were also used nearly 50,000 loaves of bread, 15 tons of cheese, and 930 tons of potatoes. The consumption of wines and other liquors aggregated: Champagne, 16,000 quarts; claret, 16,000 quarts; other wines, 9,000 quarts; mineral waters, 175,000 quarts; ale and porter, 240,000 quarts. Nearly 35,000 pounds of tobacco were used, and 64,000 cigars were sold to passengers.

THE NUMBER OF ANIMALS.

EVERY now and then, says La Science Illustrée, some naturalist endeavors to make an approximate numerical count of known animal species. This kind of attempt is surely not without interest, but it must be acknowledged that its results are very uncertain. We are far from knowing all species, and there is yet a delightful prospect ahead for those who love systematic zoology and for zoologists who bestow mutual honors by giving each other's names to some animals hitherto unknown. As M. Trouessart remarked to a recent meeting of naturalists at the Museum, to which he presented his "Catalogus Mammalium," the species of rodents known in 1880 were only 970 in number; now they are 1,900. The number has thus at least doubled in less than twenty years. The number of living species of this creature now known is about 1,500, divided among 160 genera. This family is the most numerous of the class of mammalia.

PERSIAN TIGERS.

IN the Zoological Gardens of the city of Berlin, perhaps no animals attract more attention than the Persian tigers. Our illustration pictures these two representatives of the cat family, just after they have finished their frugal noon-day meal, and are about to take their siesta in their roomy cell, in the house for beasts of prey. The Berlin zoological gardens have probably the only pair of Persian tigers in captivity. That the tiger varies both in bodily form and in the marking, color, and length of the fur, could easily be observed in the Berlin gardens, by comparing the beautifully marked Bengal or royal tiger with the closely related, but smaller island tiger. This variation became still more marked when the menagerie received its Siberian and Persian tigers. While the fur of the royal tiger, without mentioning other differences, clings more to the body, and the hair is shorter, that of the Siberian tiger is unusually thick but not so long, and hence, forms a good protection against cold. In the Persian tiger the hair is unusually long and luxurious, particularly on the head and abdomen, giving to the animal a most singular appearance. In ferocity the Persian tiger is fully equal to the other members of the great family of wild cats.—Für Alle Welt.



PERSIAN TIGERS IN THE BERLIN ZOOLOGICAL GARDENS.

ODD THINGS ABOUT CRABS.

IN the Entomostraca and barnacles, to be sure, a beginner may not be able at once to recognize the cousins of a crab. For this the young forms have to be taken into the comparison as well as the adult. It should be remembered also that what may appear inexplicable when only a few species are known becomes simple on a survey of the whole group. Still, it must always be at first rather surprising to learn that in the guise of a minute mussel we have a crustacean, and to find that by the apparatus neatly concealed within the closely fitting valves, this creature, so like a sluggish mollusk, unlike it can walk and swim about in a very lively manner. It has, too, that distinguishing mark of a crustacean, the complete shedding of its skin. For not only does it cast off the close fitting valves, but with them the coating of its jaws, its limbs, its gills, its furniture of hairs and spines. This is a wonderful piece of conjuring many times repeated every year in countless pools by myriads of these animalcules. The same phenomenon is not less common nor much less surprising in other and quite differently organized Entomostraca. But the strangeness of it will appeal more forcibly to the eye in larger forms of higher rank. At the seaside, sand and seaweed are cheap, sea water is inexpensive, an aquarium can be fitted up without much trouble. Into such a vessel let a little shore crab be introduced. Little it should be by preference because the larger ones are so mischievous, intractable and difficult to keep within bounds. Like many other wild animals, the shore crabs combine the two qualities of being extremely patient of hunger and extremely voracious. For the special object in view the guest is rather to be pampered with food than humbled by starvation. But it needs no refinements of cookery. Scraps of raw fish will content it. Still more to its satisfaction will be a supply of shorehoppers or other small shrimp-like animals, among which it can find the pleasures of sport combined with the duty of taking nourishment. In no long time, if all goes well, from ample food will result an increase of the animal's bulk. But its crustaceous envelope is not elastic. As it will not stretch, it must yield to the strain and burst. This happens, not with any irregular disruption, but as it were at certain seams, which open so neatly that they can eventually close again as if they had never been apart. With what a sense of relief must the crab, which has outgrown its clothes, shuffle off this mortal coil! After this has occurred the aquarium will exhibit two crabs, though previously it had but one. There will be a living crab with pulsating heart and circulating blood, and active brain and muscles, extending and retracting the limbs. Beside it there will be its ghost, pallid and motionless, without mind or muscle, but with the framework complete of carapace and claws, pedunculate eyes and delicate antennæ, and all the elaborate apparatus of mouth organs, œsophagus and stomach, as well as every tooth and fringe of hair with which the various parts are appropriately furnished. It is a curious spectacle to see this facsimile, this model taken from life, side by side with what may be considered its former self. The mask is empty, but the image is faultless. It is a natural sculpture above all decent cavil of criticism, although very likely the impressionist would say that it shows rather too much attention to detail.

To observe the crab in the act of coming out of its coat is not easy. It ever chooses darkness and retirement for the process, and would fain remain in privacy till its new vesture, which is soft and yielding to admit of muscular expansion within it, has acquired defensive solidity and hardness. In its tender condition it should be supplied with small and delicate food, not little spiky prawns, which might seriously interfere with its digestion. An aquarium once established may be put to a further use, for espying the behavior of some of the common spider-crabs. Many of these have long been well known objects. Overgrown with living seaweeds, and sponges and zoöphytes, they look not a little disreputable. Their unkempt and disorderly appearance recalls to mind the description of the field of the sluggard. They seem to be in evil case, the due reward of their own disgracefully indolent habits. But things are not always what they seem. It now turns out that these crafty animals, for their own purposes, deliberately prefer to look like a bit of wild submarine landscape. Nor do they leave the matter to chance. They very carefully dress and undress themselves, so as to be in harmony with their surroundings. This is no doubt a question of taste, though not exactly in the æsthetic sense. The experimental proof on which their new character has been established can easily be

repeated in an aquarium, either by stripping the specimen of the dress it actually wears, to see whether it will or will not renew it, or else by introducing it into a miniature forest differently colored from that on its own back. This is the most interesting experiment; for, if it succeeds, the crab will itself strip off the plants and animals which form its garb, and in place of them, carefully affix a fresh plantation from its new neighborhood.—The Nineteenth Century.

FUNCTIONAL RESEMBLANCES BETWEEN ANIMALS AND PLANTS.

By ALICE DINSMORE.

RECENT methods of scientific investigation, in which the microscope plays so large a part and painstaking experiments prove the truth or more often the falsity of old theories and establish new ones, have, perhaps, done nothing more stimulating to the spirit of research than to show how close are the relations and resemblances among the various forms of life. The discovery of similarity of phenomena in what we call animals and plants has gone far to break down old-time distinctions between them. The explanation of many of these phenomena, hitherto either looked upon as inexplicable or passed unnoticed, especially those pertaining to the dependence of higher forms of vegetable life upon lower, and of animals and plants upon each other, gives us a sense of the unity of interest in the natural world before unrealized. The gardener in his fight against destructive insects gets his best assistance from other insects—birds and bacteria. Forest trees and ornamental shrubs are fulfilling their large part in the economy of nature, because the humble mycelia are their servants, while the clover in the meadow yields its abundant crop because bacteria live on its roots and supply the nitrogen it needs.

Animals, from the ant to the elephant, show what we call remarkable "instinct" in their choice of food. So do plants. The organs of animals are marvelous in adaptation to the functions they perform; but hardly more so than those of plants.

While almost incalculable labor has been spent in classifying and naming the visible plants in the world, the true key to what Linnæus and De Candolle and their successors saw, and to much that escaped them, has been found in the microscopic study of the forms invisible to the naked eye.

It is not long since both zoologists and botanists were contending for the volvox; but the zoologists have yielded their claim and now admit that the globe-like organism which rolls through the water propelled by hair-like projections from each of its protoplasts is a plant. The mystery of the so-called "red snow" is solved. We know that it consists of minute vegetable organisms, algæ, the green chlorophyl being disguised by blood-red pigment. When the snow on which they lie melts, the cells divide, free themselves, assume oval shape, send out two rotating cilia, by which they move and swim about.

In an exhibition given by a microscopical society not a hundred miles from New York within a few years, I have seen a slide of diatoms labeled "animalcules." The truth is these diatoms do act very much as we are accustomed to thinking only animals can. Their siliceous coat has two valves, which open and enable the protoplast within to glide along near the bottom of the pool where it lives.

Notwithstanding the activity that all these three organisms show, scientists are classifying them where they do bacteria, among vegetables, by virtue of their reproduction by means of spores.

The freedom of movement among bacteria is among the most interesting of their characteristics. One species has been named Bacterium photometricum, because it is specially affected by light. If a microscopic preparation containing them be so placed that the light is stronger in one part of the field than others, the bacteria will be seen to collect in this spot. If in its movement one bacterium gets out of this bright spot into a dark part, it stops instantly and goes back to the illuminated place; thus such a portion of the field becomes a sort of trap for bacteria. This is called still in scientific works the "movement of alarm." It was probably the same old idea of instinct as belonging to creations that move that led men to give the name of "rovers" to some of the bacteria found in the nodules on the roots of clover, peas and other leguminous plants. They are among the very smallest of organisms, and yet they move about on the plate where they are being cultivated and form new "colonies" where they please.

But all these signs of animal-like activity must be taken on faith by those who are not fortunate enough to use microscopes. However, people who are observing, and know where to look, can see with the naked eye evidences of activity among plants that are most curious and interesting. Eel grass (Vallisneria spiralis) for instance repays close watching, and will thrive in an aquarium. In its native haunts, this plant lives in slow-running water. It is stemless and dicecious, that is, the staminate or male flowers and the pistillate or female flowers are on different plants. The staminate blossoms come to maturity under the water, but before the anthers burst to discharge their pollen, the blossoms free themselves from their short pedicles, and coming to the surface, shed their pollen there. Meantime, the pistillate flowers, which are borne on spiral stalks, uncoil at the surface of the water, and so are there to receive the pollen on their stigmas. Having taken it, they coil up again and draw the ovary down under water, where the seed matures. The staminate blossoms having done their work, wither. This is an exhibition of what some writers are pleased to call "instinct" in plants. The Kenilworth or Coliseum ivy (Linaria cymbalaria) is not far behind in activity and apparent purpose. It raises its flower stalks from the stone wall over which it creeps toward the light, but as soon as fertilization has taken place, the stalks curve in an opposite direction, so as to deposit the seeds in a dark crevice.

In this connection the sundew (Drosera) must not be omitted. It has been made famous by Darwin's observations and experiments upon it, which nearly fill his volume on insectivorous plants. Forty species of it are known, though only five are given by Gray as native in our country. The sundew grows in boggy moors. Its leaves are beset with tentacle-like filaments, each having at the end a drop of sticky juice. Insects are attracted by it, stick to it, trying to get away they are covered the more, and are finally smothered. The contact of the insect increases the secretion. A few minutes after a gland in one of the marginal tentacles has been excited, the whole fringe begins to move, and in the course of from one to three hours, all the tentacles are bent and converge on the hapless insect. If two insects happen to get caught on opposite sides of the leaf, the two hundred tentacles will divide into two groups, each surrounding one victim. Two or three leaves sometimes unite in capturing a dragon fly. Other things, like bits of paper, dried moss, or cork, put on the leaf, excite the tentacles more or less, sometimes enough to be well inclosed. But bits of raw meat and egg—like insects, nitrogenous food—are well grasped, and in the course of some hours are digested. The flesh and blood of midges, flies, ants, etc., caught are wholly absorbed, while dry parts like the eyes, wings, etc., are not taken, but are left on the tentacles, and when they reopen, are blown away. The molecular change that goes on in the cells of the leaf is noteworthy. When the tentacles are excited by contact of the insect, the purple liquid in the cell cavities separates into a colorless liquid and dark, roundish lumps. This change can be watched as it is propagated along the cells of the first tentacles touched, and from that to the others. When the insects have been digested, the lumps disappear, and the colorless liquid resumes its purple color. So sensitive are these tentacles, that a bit of hair too small to be perceived on the human tongue produces movement in them. But this is not all. Active as the leaves are when the nourishment of the plant enters into the question, drops of rain or quick blows with a hard object do not cause any bending of the tentacles. The juice of the leaves shows properties like those of the digestive fluids of animals, and their function in the life of the Drosera appears to be like that carried on in a stomach. Lafar in his recent "Technical Mycology" states that bacteria which find lodgment on the leaves undoubtedly have their part in the digestive process.

Other plants, notably the Penguiculæ, with their two kinds of glands and 25,000 secreting cells on the square centimeter of leaf, the various pitcher plants and allied forms, all secrete a true digestive fluid. It is by this means that they obtain the nitrogen they need, which, from their structure or situation, is not otherwise obtainable.

Moreover, plants show in other ways what may be called selective power in the choice of their food, a power which so far science fails to explain. Kerner, in his great work on the "Natural History of Plants," gives a number of comparative tables to show the salts found in the ash of plants of different species growing in the same soil. It will suffice to give the analysis of the ash of two, the first belonging to the Cruciferæ, the second to the Convolulaceæ. They grew on the side of a mountain with their roots interlaced.

	(1) Biscutella lævigata. Per cent.	(2) Doryculum decumbens. Per cent.
Potash	9·6	16·7
Calcium	14·7	20·9
Magnesium	28·0	19·6
Iron oxide	7·8	2·8
Silicic acid	13·0	6·0
Sulphur	5·2	1·6
Phosphorus	15·9	22·3
Carbonic acid	5·4	9·7

Careful tests show that the same species in widely differing localities take the same food in virtually the same proportions. Furthermore, plants succeed in getting out of soil and water the salts they need when they exist there in minute quantities. For instance, a pond lily examined showed that chloride of sodium constituted one-third of its ash, and yet the bog water where it grew contained very little salt. Diatoms have been found where no trace of silicic acid could be detected in ten liters of the water evaporated. In such a case, doubtless the air supplied the needed mineral. These illustrations of resemblances between animals and plants, and many more that might be given, have their general explanation in the fact that protoplasm is the physical basis of the life of both, and that what we call sensation in animals is virtually the same in plants.

WINGED CARRIERS OF DISEASE.

A FEW years ago, while visiting America, it was my privilege to spend the first week in that enlightened country in a fly-proof dwelling. The season of the year was September. The place was Beverley Farms, and my host was the most agreeable and witty man of his day, the distinguished physician, novelist, and poet, Oliver Wendell Holmes. His summer residence was one of many similar villas placed in various clearings of the woods skirting the Atlantic, and presenting in all directions exquisite views of sea and land. On entering the villa it was curious to find the folding doors silently closing up behind, while others mysteriously opened in front through some mechanical contrivance, the object of which was to keep out the flies. Every window in this Arcadia was protected from the entrance of flies by wire gauze stretchers through which the summer breeze could be wafted during the hours of sleep, and which was transparent enough to allow your eyes to rest on the pretty garden below in the hours of morning. These windows were a revelation of what intelligence and art could do to secure comfort and ease to the occupants of the dwelling. In addition to the ordinary glass windows of everyday life, there were Venetian shutters made to open and shut in sections, and to turn this way and that at will. These effectually kept out the rays of the sun, and enveloped the room in welcome shade with glints of light at pleasure. Again, while lounging under the veranda—or piazza, as it is called—there was a charm in hearing the bees humming, the wasps buzzing, and in seeing the air full of fly life, and feel you could read in comfort and meditate in peace. In fact, the place of your dreams by day and by night was carefully guarded by fly-proof transparent wire gauze.

Then à propos of the fly-proof dwelling, our philosopher loved to discourse on the part played by these busy curious creatures round about us, some engaged in gathering honey, others acting as scavengers, many doing duty as carriers of the pollen to the plant—all engaged in a general scheme of co-operation throughout nature. Still, their place in nature, we agreed, was distinctly outside the gauze barriers. Inside the dwelling house they were not wanted; there they did not give rise to poetic musings; there they could only do mischief by attacking our food in the larder and on the table; by making raids on the jam pots, and falling into the cream, and generally provoking language not always parliamentary. But as things were, in this peaceful and harmonious spot, we could afford to sit out on the lawn and speculate on the business of life going on through the sunny air, and reflect with delight that the perfume around, and the colors radiating from the flower beds, were simply nature's sign posts guiding many of these little winged creatures to the nectar of their quest. But far beyond our little earthly paradise, our Arcadian speculations, our barriers of gauze, there was another story to be told, another side of the picture to be realized; one not less interesting to the physician nor less important to humanity, and that was the influence of flies in carrying about the seeds of human disease.

It has long been known that ophthalmia could be spread by flies, and that erysipelas, ringworm, and various forms of eczema could easily be transmitted from one subject to another by flies. At a recent meeting of the Royal Society, Mr. Burgess had a very interesting exhibit showing the result of some experiments carried out to prove the influence of flies in transplanting the seeds of bacteria. He had captured some common house flies and placed their feet in momentary contact with a growth of the Bacillus prodigiosus. This is the bright red bacterium familiar to housekeepers in damp, ill-lighted larders, for it starts out in red patches on bread, boiled rice, and sausages, and has been known to turn rain red, and milk the color of blood. With their feet touched with this growth, he allowed his flies liberty to roam for several hours in a large room. Meanwhile he prepared a suitable soil for his experiment by cutting slices of sterilized potato, and, having recaptured his flies, caused them to walk over this culture ground. In the natural course of time he had the satisfaction of seeing a perfect garden of the Bacillus prodigiosus spring up wherever their feet touched.

To pursue this investigation into the more serious regions of pathology, similar experiments were conducted with the diphtheria bacillus on coagulated serum, but within defined limits. "Four dishes containing this material were arranged in the following order:

"No. 1, containing sterile coagulated serum.
"No. 2, containing culture of diphtheria on serum.
"No. 3, containing sterile coagulated serum.
"No. 4, containing sterile coagulated serum.

"A common house fly was made to walk over the four surfaces of serum in the order given. Dishes 1, 3, and 4 were now placed in the incubator. No. 1 next day showed some harmless cocci only; Nos. 3 and 4 showed colonies of diphtheria bacilli in the tracks of the fly.

"We have here a simple explanation of one method of contaminating milk and other food preparations. In that flies, however, are absent in winter, when diphtheria prevails, they cannot be regarded as a great factor in the spread of the disease; but in all probability they have some influence in helping to swell the autumnal rise in the prevalence of diphtheria."*

With regard to cholera, it was found that when house flies were fed with pure cultures of that disease, the bacilli were found in their intestines and excreta up to four days later. Further, if in addition to the pure cholera culture a little sterilized broth were added, then immense quantities of bacilli were found, indicating that they not only thrive but multiply in the bodies of the flies.† Thus may the seeds of cholera be insidiously deposited on food or in milk to develop into the full-blown disease in the human body. These, then, are some of the primitive ways in which disease may be spread, for the germs not only live in the water and the soil, but in the air, ready to fall on everything about us within easy access to flies.

In addition to these direct ways of transplanting the seeds of disease there are other and more roundabout methods known to science by which certain flies, fitted by nature with a complete inoculating apparatus, introduce into the human blood the germs of deadly diseases. These flies are chiefly mosquitoes—not all mosquitoes, but certain species, that not only have the power, as we shall presently see, to elaborate the germs of human diseases within the area of their own bodies, but are gifted with the power of extracting these germs from the blood of man, and of giving them back to man again.

To follow this study it will be necessary to transport ourselves mentally to those tropical lands where insect life abounds, and where the mosquito house of science has been adopted to keep mosquitoes in, by men devoting their lives to unraveling the mystery of the connection of these insects with disease. In China, South America, and countries where different forms of elephantiasis prevail, this deplorable disease has long been associated in the medical mind with a certain species of mosquito; hence the searching investigations that have brought to light the life history of the bloodworm, Filaria sanguinis hominis, its partnership with the mosquito, and the effect of its presence in the blood and tissues of man.

In order to trace this disease and its associated parasite to the mosquito of his suspicion, Dr. Manson in far-off Amoy established the first mosquito house deliberately planned for the investigation of disease. He had no difficulty in persuading, for a little consideration, certain of his hospital patients suffering from filarial infection to become midnight tenants of his mosquito trap. Far from feeling the victims of science they considered themselves in luck's way, and willingly gave assistance in the laboratory. Hence, when night came round, the coolie of research was quietly put to bed with a lighted lamp beside him for the first half-hour to lure the mosquitoes in. The curtains would then be closed till morning. At break of day the coolie would emerge carefully, and, after satisfying himself that he had been sufficiently well bitten for the purposes of science, would proceed cautiously, with the aid

* Captain Fred Smith, Public Health.
† Sawtschenko.

of tobacco smoke, to capture the mosquitoes and carry them off alive to the laboratory.

When the fresh-drawn human blood was taken from the body of the mosquito and placed under the microscope, innumerable actively moving embryo filariæ were found in it. These are the progeny of a parent worm, which, by blocking the lymphatic vessels, is the cause of the hideous disease very appropriately called elephantiasis. To the naked eye these embryos are invisible, but under the lens they appear as long snake-like creatures having perfectly transparent, almost structureless bodies confined in a delicate tube or sheath. Within this tube they are seen to extend and shorten themselves with very active movements.

These movements are remarkable as indicating a sort of perception on the part of the immature parasites that they have now escaped from the prison house of the human body, within which they cannot further develop, and where, if they remain unreleased, they have to be content with lifelong infancy. These movements, therefore, are efforts on the part of the embryos to shake themselves free from the sheaths which inclose and muzzle them, in order to enter on the next stage of their existence outside the human body and inside that of the mosquito. When by their continued efforts they have escaped from their sheaths, the filariæ move from place to place till they suddenly vanish from the blood in the insect's stomach, leaving the sheath behind. For a long time it was difficult to know what became of them, but they were eventually tracked and found embedded in the thoracic muscles of the mosquito, and here in this quiet little nursery they go through a further stage of evolution by developing a mouth, an alimentary canal, a peculiar trilobed tail, and an enormous increase of size and activity.

During this period of development on the part of the filaria the life of the mosquito is naturally drawing to a close. Her nocturnal activities are over, she languidly digests her last meal, and takes up her quarters in convenient proximity to the nearest water tank or stagnant pool. At the end of a week from her last repast she lays her eggs on the surface of the water and dies. On the water the ova look at first like a little flake of soot, then spread, each egg taking the graceful form of an Etruscan vase, through the lid of which the mosquito larva escapes in due course to complete maturity in the water.

But where now are the embryos of our research? They have by this time reached a stage of development which enables them to bore their way out, and to quit the body of the dead foster mother. The new element in which they find themselves is one for which they have been prepared, and there in the next stage of their existence they lie in wait for the hapless passer-by who stops to drink, and whose unsuspected métier it is to carry through, and bring to completion within his body, the life history of the organism. If only the male or the female filaria be swallowed, no mischief ensues; but, as the two sexes are usually grouped together, the chances are that two or more of both sexes are imbibed at the same time. When once received into the human body they soon work their way through the alimentary canal, the female following the male to their last resting place in the lymphatic system of their final human host. Arrived there, development becomes perfected, fecundation is effected, and the embryo filariæ are discharged in successive swarms and countless numbers into the human blood. The strange thing is that Nature so provides for the preservation of this malign species that, although she is lavish of the embryos which are excreted and lost in a variety of ways, she arranges that the blood-stream of the human being should bring the embryos to the surface at the natural feeding time of the mosquito—that is, during the night. If the blood of the coolie is examined in the daytime, no embryos are to be found; they come into the general circulation only during the evening or night, hence the name of filaria nocturna given to distinguish this particular species from others. Further, it is the female mosquito alone who takes part in this co-operation, for the male mosquito throughout nature is not endowed with the necessary apparatus for drawing blood, and is mildly content to live on the juices and exudations of plants and fruits.

It is, no doubt, difficult in our temperate climate to realize fully the widespread suffering due to tropical diseases, but in these days of easy traveling the waifs and strays of tropical humanity often drift to our English hospitals to die. Lately there were two Congo negroes in Charing Cross hospital dying of "the sleeping sickness." In a drop of their blood swarms of embryo filariæ were seen, similar in many respects to those just described, but belonging to a different species, and, consequently, giving rise to different symptoms. In their case there was no disfigurement of the body, and the embryos pervaded the blood-stream uniformly day and night. The patients had to be roused to take food, but, in deep melancholy, they immediately dropped to sleep again, indifferent to life and its surroundings. In these cases it may be that the parent filariæ or their progeny in some unknown way affect injuriously the brain of the victims of this mysterious and deadly infection. Among slaves this disease was very common, and as the sleepiness was generally attributed to grief at being parted from relatives, and to idleness, the consequences may be imagined.

As a result of these early researches, it is now being revealed to us that a more familiar disease, and one much nearer home—namely, malaria—can also be inoculated into the human blood through the bite of certain mosquitoes.

It is well known that malaria is generated in swampy places. Such places are notoriously the haunts of mosquitoes. The spot of evil omen may be a puddle under the bedroom window, or a mile of swamp a mile away.* When the germs, introduced through the proboscis of the mosquito, have made their way into the human blood, they find there all they require for their subsistence and a nursery favorable for reproduction. The various stages of their life-history are found to be synchronous with the various stages of ague and fever on the part of the patient, and it is highly probable that the various types of malarial disease may yet be traced to different species of parasite, each demanding its special variety of mosquito.

In a little hospital at the Albert docks the other day, surrounded by the big ships that bring to it their daily freight of disease, I was allowed to watch part of this life-history under the microscope. The assistant had taken a drop of blood from a patient's finger a moment before, and placed it under the lens. The next moment I was watching the whole dramatis personæ—if I may say so—of the tragedy in real life being enacted within a few yards of where I sat. There were the human blood-corpuscles in every stage of health and disease, some laden with the little black-speckled amœbæ (malarial parasites), others showing the spherules of a more advanced stage of its development. There were also present one or two of the large white cells called phagocytes, which exist naturally in all blood to act as scavengers for clearing it of foreign matter. As I watched, there emerged from a group of corpuscles the pale, creeping form of one of these phagocytes, which began slowly to engulf and draw into its transparent body some of the little black parasites.

Except for these slow movements all was quiescent until suddenly there was a commotion; something in my microscopic world had happened; in another moment parasites and blood-cells were being violently churned up together. The explanation was that one of the malaria parasites having now been about a quarter of an hour outside the human body was passing through an extra-corporeal stage of its life! It had suddenly thrown out flagella, as they are called, long, waving filaments, which were trying to shake themselves free from the mother parasite and proceed to the fulfillment of their destiny. In common with the embryo filaria in its sheath, the malaria germ seemed to be cognizant of the fact that it was now released from the human body, and was, therefore, ready to adapt itself to the new conditions. The purpose of these flagella long remained a mystery till Prof. MacCullum, of the Johns Hopkins University, Baltimore, discovered their object while investigating malarial disease in the crow. He found that the function of the free flagellum was to impregnate certain parasitic cells that do not develop flagella. When this takes place, the impregnated spheres slowly change shape and become converted into locomotive vermicules, containing the entire substance of the original sphere, including the little black masses of pigment which are so characteristic of the malaria parasite in all its more advanced stages. To learn the future of this "traveling vermicule" we must now follow, or try to follow, the recent marvelous investigations of Surgeon-Major Ross in India—investigations which have been confirmed by Koch, and Bignami in Italy, and other savants.

In order to carry out these particular researches, Major Ross settled himself in the midst of mosquitoes at Calcutta. Here he established a mosquito laboratory, and opened up communications with Manson, his collaborator at the little hospital just referred to at the Albert docks. With the aid of the post, the telegraph wires, and microscopes at both ends, this work was quietly begun five years ago, till its importance was recognized by the whole scientific world, and its expansion was promoted and encouraged by the governments of India and Great Britain.

In his primitive laboratory Ross had first to discover which of the mosquitoes among many species were the agents that "liberated" the malarial parasites from infected blood, and found that the dapple-winged, barred-backed, and gray mosquitoes were the chief agents. With them he set to work and pursued his experiments on the infected and uninfected blood of man and also of birds, many of which are extremely susceptible to this form of disease. After sacrificing hecatombs of mosquitoes, he found that by feeding the gray mosquito (which he cultivated pure and healthy from the pupa) on sparrow's blood containing the parasites, he could with the utmost certainty get from the mosquito's stomach a crop of pigmented cells resembling those he had similarly raised from human malaria.

In watching the progress of events within the body of the mosquito, he found that the malarial parasite had power to develop and multiply and go through even more advanced stages of its life history than it had the power to do within the blood of man.

It seems that when the parasite is liberated from the human blood and enters the mosquito, certain cells (spherical in form) throw out flagella which, breaking loose, approach and enter other spherical cells, as already mentioned, causing them in turn to assume an elongated shape endowed with active locomotive powers. This is the "traveling vermicule" phase, which, in virtue of its penetrating power, enters and becomes embedded in the muscular wall of the mosquito's stomach. When once it is there embedded, it continues to grow and pass through various stages of evolution till it begins to project from the interior of the stomach a number of little cysts, which protrude on the outer surface. Within these cysts order is being daily evolved out of primal chaos. On the fifth day the cells, rapidly developing inside the cysts, have ranged themselves into two kinds: (1) Those that contain numbers of delicate thread-like bodies and (2) those that contain large black spore-like bodies, both kinds being probably reproductive. On the eighth or ninth day, when maturity is reached, the cysts burst and pour their contents into the general cavity of the insect's body. The circulation of the blood stream is now pressed into the service, and, singular to relate, while it carries the black spores into the tissues, it sends the thread-like objects (now called germinal rods) more especially into the poison glands, which are on each side of the proboscis of the insect. In the salivary poison glands the rods remain ready along with the secretion to be inoculated into the human or bird blood directly through the bite of the insect, causing the well known irritation in the first instance, with possibilities of malarial fever to come.

From this it will be seen—and not without pleasure by a vindictive world—how much the hated mosquito has to do. Thinking only of her offspring, she has simultaneously to bear the double family of the parasite, who takes possession and crowds her young into every nook and cranny of her body. Her muscular tissues are pressed open, her thorax is made into a nursery, her stomach is rendered hideous by innumerable wart-like cysts, while her entire body is converted into a scientific laboratory for the cultivation and distribution of a deadly disease! Some of the progeny she can and does dispose of when feeding on susceptible blood, but there are always more to come, till finally the remainder are passed on to the next generation, when the young mosquitoes emerge from their Etruscan vases and begin to feed on the dead body of the mother left lying on the pool of their birth.

So deeply interesting have these investigations proved that they have been closely followed by the sappers and miners of microbiological research everywhere. In this way some knotty points have been unraveled and lost threads found; but all are unanimous in according to Ross the honor that is his due.

Since the door of this new road to knowledge has been opened, chiefly by Manson's researches on the filaria nocturna, much attention has been devoted to the transmission of disease by other insects. As a result, the researches of Kilborne and Theobald Smith have clearly demonstrated that the germ of Texas fever in cattle—a germ closely resembling that of malaria—is conveyed by the cattle tick and communicated by the bite of this animal. If cattle swallow the tick or its eggs in food, no harm follows, because the parasite requires to be inoculated into the blood directly by bite of the insect before it can cause fever by destroying and disintegrating the blood corpuscles, as in malaria. Further, it has been ascertained by Prof. Celli, of Rome, that when cattle in the districts in which this fever is endemic are kept in sheds and protected from ticks they do not develop this form of malaria, while those outside and unprotected fall victims.

Bruce also has shown that the fly disease in Africa—not the least formidable of the many obstacles to the civilization of that country—is caused by a blood parasite which is conveyed from the tick to the sound animal on the mandibles of the Tsetse-fly.

In the silkworm disease Pasteur was able to prove that pébrine was communicated by the worms crawling first over the infected excreta and then over each other, inflicting little pricks with their sharp claws. Hence elephantiasis and malaria in man, pébrine in silkworms, Texas fever in cattle, the fly disease of Africa, are all diseases proved to be transmissible directly or indirectly through inoculation by insects. Malaria may and in all probability has other means, as yet undiscovered, of finding an entrance to the human blood, but those methods just described serve to show how the winged creatures of the air may carry disease and possibly death into our homes.

When we consider the losses to our armies abroad, to industry and agriculture, and the sufferings to humanity generally involved in these tropical diseases, it is singular to reflect that the preventive measures indicated by our knowledge are so simple and so homely. For pébrine, the use of the microscope, wherewithal to examine the dead body of the moth before allowing the eggs to develop, and attention to perfect sanitation in the silkworms' home, has restored a moribund industry to France, Japan, and other nations. For the rest, the fly-proof dwelling, the tick-proof shed, the mosquito curtain, the filter, are all simple and attainable barriers against these diseases. In India vast sums are spent in slaying the man-eating tigers and poisonous snakes of the jungle, but their power of destruction to human life is as nothing compared to the power of the unseen enemies that haunt not only the jungle and the swamp, but the cities of the East, and steal into the blood of men, animals, and birds, through the subtle agency of unsuspected flies!

In the midst of these reflections it is satisfactory to know that the government of India so well appreciates the benefit to mankind likely to arise out of these researches that it now provides the whole of the expenses for Ross' laboratory. Further, our Colonial Office, with a keen recognition of widespread benefits to come, has given a grant of nearly 4,000 l. toward erecting a school for the teaching and study of tropical disease in connection with the Seamen's Hospital at the Albert docks. It is by such means we hope to attain the necessary knowledge and, by imparting that knowledge to others, be enabled before many years have passed not only to save much human life, but to turn those parts of the tropical world at present uninhabitable into smiling lands and productive gardens, where our fellow creatures may enjoy health and prosperity, and live in peace with all mankind.—Eliza Priestley in The Nineteenth Century. By permission of the Leonard Scott Publication Company.

* Ross.

SUGAR OF MILK.

OF the great variety of drugs and chemicals which play an important part in the commerce of the world, little is known by the general public. The importation into the United States of balsams, barks, beans, flowers, gums, herbs, and leaves gathered from every part of the globe foots up in value annually to nearly $50,000,000, while the exports of similar products from this country have reached a total of about $10,000,000. But of the hundreds of different names on the list with which the importer and wholesale drug dealer are familiar there are scores which are almost perfect strangers to the lay mind. Along with alcohol, borax, opium, quinine, and other well known drugs will be found cantharides, cocculus Indicus, crystallose, lycopodium, meligan, cutch, buchu, chicle, and others of equally enigmatical character.

In this latter class might almost be mentioned sugar of milk, which occupies one of the most important positions in the drug transactions of the present day. The title of the drug would imply common knowledge, though as a matter of fact few understand its important uses. Time was when every ounce of this drug was imported from Europe. To-day, thanks to American enterprise, it is manufactured in the United States on such an extensive scale that not only is the enormous domestic demand supplied by the home-made product, but large quantities are annually exported. When it was imported the wholesale price was 90 cents a pound; now it has declined to 8 cents. History says that sugar of milk was first prepared in 1619, although not introduced into medicine until 1698. It is used almost entirely by pill manufacturers on account of its neutral, filling properties. It is absolutely neutral, inodorous and with a slightly sweet taste. As a vehicle for all manner of pulverized medicines it is perfect. Acids and drugs of all kinds, with which it may be mixed, do not have any effect upon it nor it upon them,

and in the human stomach it is most easily disposed of. It is manufactured from the whey of cow's milk, and is really a by-product of milk. The process is one of evaporation and recrystallization. Switzerland once had a monopoly of its manufacture. Now Illinois leads the world, while a large factory has been started in New York State, which gives promise of producing as much as its Western predecessor. Such has been the success of the American industry that the product is shipped even to Switzerland, where it is able to compete satisfactorily with the European makes.

In crystal form it resembles rock candy, being white in color. The growing demand for it has been caused by the development of patent medicines in pill and tablet form, where bulk is desired. It is said to be exported in the form of powdered sugar for the reason that low freight rates are thus secured. Otherwise, as a drug the cost of ocean transportation would be largely increased.—New York Tribune.

THE WEAR OF MODERN GUNS.

THE substitution of smokeless for ordinary gunpowder has valuable advantages that have been very often pointed out, and which consist in the suppression of clouds of smoke, in the progressive ignition of the powder, and in a greater velocity imparted to the projectiles.

But all smokeless powders, such, for instance, as melinite, cordite, etc., have one drawback, which is becoming more and more apparent in measure as the use of them becomes general; their deflagration corrodes and very quickly ruins the interior of the gun and renders it unserviceable.

This question well merits the attention that it has received for some time past, since it is a very important one. In fact, during times of peace, it is necessary to use guns for the drilling of the men who are to serve them, and repeated firings have the effect of quite rapidly impairing the most costly weapon without the latter having rendered the least effective service.

We are now able to place before the eyes of our readers some reproductions of photographs which relate to this question and which were recently presented by Prof. W. C. Roberts-Austen to the Iron and Steel Institute. They have reference to a 120 mm. rapid fire gun tube, of which a section was made at about four meters from the muzzle. The first figure represents the section under consideration, where, despite the reduction, the erosion caused by the powder may be plainly seen. Fig. 2 gives a section at right angles with the axis of the gun, and shows what remains of the original rifling, that is to say, of the sunken and projecting portions. The dotted line, *a b*, shows the original profile of the rifled surface of the tube and permits us to see how large a quantity of metal has been removed at *d* and *e* by the powder and its gases. The enlargement here is 33 diameters. In Fig. 3, in which the enlargement is the same, a front view of the erosions is given. The light parts represent the depressions of the rifling, and the dark ones the threads in relief that give the projectile a rotary motion.

These photographs show the ravages that are caused by smokeless powder, and which are exhibited by very perceptible effects in gun tubes simply after five trial shots. English powder or cordite was employed in the piece, of which the interior may here be examined. As for the metal of which the tube was formed, that was gun steel of the normal type, containing about 3 per cent. of carbon, 6 per cent. of manganese, 0·15 per cent. of silicium and a quantity of sulphur and phosphorus not exceeding 0·05 per cent. The tube was tempered

FIG. 2.—SECTION AT RIGHT ANGLES WITH THE AXIS OF THE GUN.

a, *b*, original profile.

with oil after being raised to a temperature of 800°, and was afterward annealed at 500°.

Those who have studied the question under consideration generally conclude that what is most important therein is the mechanical treatment to which the metal is submitted; but no means have as yet been found to prevent the abrupt elevation of temperature followed by a rapid cooling that occurs at the moment of the explosion. This is accompanied with changes which are facilitated by the mechanical action of the passage of the projectile.

For the above particulars and the engravings we are indebted to La Nature.

AMERICAN TRADE IN BRITISH EYES.

REVIEWING the general outlook for business in the world at present as affecting British trade prospects, The London Statist says: In the United States the expansion of trade is proceeding with great rapidity. Up to the end of last year, three good harvests in succession had enriched the farmers and given a great impetus to the traffic of the railway companies, but trade proper had not grown as people in general had expected. Since the new year began, however, both prices and wages have been rising rapidly. Orders are being placed in great numbers, and it is said that many manufacturers are already booked fully six months ahead. There are some industries still behindhand—wool, for example, and anthracite coal. But

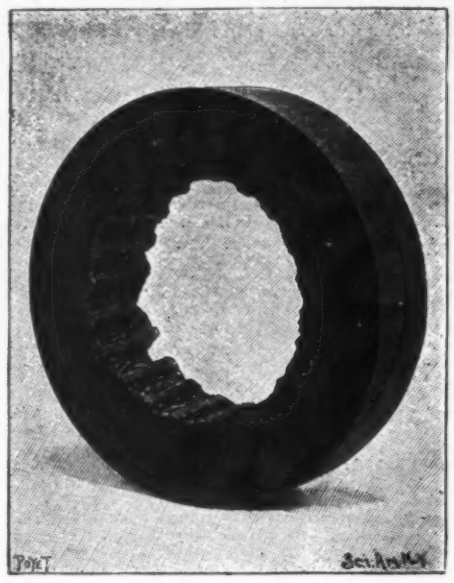


FIG. 1.—SECTION OF THE TUBE OF A RAPID-FIRE GUN.

speaking broadly and generally, the trade of the United States is growing marvelously, and is likely to continue to grow unless the new crops should prove very bad indeed, or something untoward, now altogether unforeseen, should occur. If trade in the United States grows as it is growing now, American purchases of European goods will necessarily increase. The Americans, like ourselves, always increase their consumption of comforts and luxuries when they are doing well, and there is no question that they are doing well at present.

THE TINPLATE TRUST.

A VERY interesting illustration of the operation of the average American trust is afforded by the case of tinplate. It will be remembered that this industry in the United States dates virtually from the operation of the deferred schedule of the McKinley Tariff Act; in other words, it has grown up—has been made possible, in fact—by the aid of very heavy duties. Its rapid and enormous expansion in the short space of eight years, together with the effect upon imports, will be seen at a glance from the following tabular statement, which is based upon the official statistics:

	American Production. Pounds.	Imports. Pounds.
1891	2,000,000	732,000,000
1892	42,000,000	600,000,000
1893	124,000,000	567,000,000
1894	166,000,000	482,000,000
1895	225,000,000	490,000,000
1896	369,000,000	261,000,000
1897	575,000,000	179,000,000
1898	730,000,000	150,000,000

It may be well to point out here that under the tariff law of March 3, 1883, tin plates were subjected to an import duty of 1 cent per pound. As the article was not produced in the country then, the import duty represented a taxation for revenue to the average amount of about $5,500,000 a year, from 1883 to 1890. The tariff law of October 1, 1890, raised the duty at once from 1 cent per pound to 1¾ cents per pound, or from $1 per box to $1.75, with the further provision that from July 1, 1891, the import duty was to be 2 2-10 cents per pound, or $2 20 per box, should the amount of tin plates produced in the United States during any of the six years preceding June 30, 1897, equal one-third of the amount of tinplates imported and entered for consumption during any fiscal year prior to October 1, 1897.

This act stimulated the building of tinplate mills in the United States, and by the time the framers of the Dingley tariff began to work, the production had reached the home consumption, and enough new mills were in course of erection to make a new outlet desirable. Under such conditions the Dingley tariff raised the import duty from $1.20 to $1.50 per box of 100 pounds. At first no attention was paid to such a ridiculous proceeding. In fact, at that time the price for American product included but one-fifth of the import duty of $1.50 per box. The importation of tinplates had ceased, with the exception of those used in manufacturing cans for petroleum for export, on which the duty was remitted. It is notorious that, but for this, we should by this time have not even a shred to hang on to of trade in tinplate with America.

It will be clear that, when the trust mania began to develop, this particular American industry was eminently amenable to its influences. The trust was formed late last year. To-day it deserves the phrase which has been applied to it of being "one of the most compact organizations extant." Its control of the market is absolute, no competition with it being possible so long as the duty of 1⅛ cents per pound is maintained. It owns virtually, if not literally, all the mills in the United States, of which there are about three hundred, and it controls all the raw materials which enter into the manufacture of tinplates. For, as we have ourselves pointed out, it is so interlocked with the other great steel and iron trusts—the National Steel Company, the American Steel Hoop Company, the Republic Iron and Steel Company, etc.—which are the producers of the materials for the making of tinplates, as to render competition with it out of the question. In December last, at about the time when the trust was under formation, American tinplate was being manufactured and sold for a fair profit at $2, the price of the English product being $2.60, exclusive of the duty. During the next month the trust put the price up to $3.20, the English price being still $2.60. In February the trust's prices ranged from $3.45 to $3.70, the English article being steady at $2.65; in March the trust raised the price to $4.10, the English product being sold at $2.70. In April the trust did not change its price, but the price of the English article was advanced to $2.80.

Thus it will be seen that within three months the trust added 50 per cent. to the cost of tinplate, and, says one American critic, "about 75 per cent. of the $1.20 increase in the difference between the prices of American over English tinplate from November to March must be charged to the arbitrary tariff-given monopoly power of the Tinplate Trust in America." Naturally its action has occasioned much indignation on the part of the consumer; but what can the consumer do? The trust has got the screw on, and no doubt it will keep on squeezing the helpless users of tinplate until the Legislature intervenes—which the Legislature will not do, we suppose, until the present administration is turned out.

It is consoling to honest trade competitors to think that such abuses as these will open the eyes of the American people before the next Presidential election to the real incidence of the Dingley duties, and to the dangers which they are piling up for the country. It has been urged of late that all the trusts which have been called into being and sustained by excessive duties should have the props and pillars which uphold them removed by the repeal of such duties. Tinplate is a good article to which that rule might be applied.—Engineering.

THE RUINS OF XKICHMOOK, YUCATAN.

THE group of ruins in Yucatan called Xkichmook was discovered by Mr. Edward H. Thompson in 1888, when he read a paper before the American Antiquarian Society embodying his first impressions of it. He has since made studies of it extending over a period of seven years. The group is about one hundred and forty miles south of Merida and forty or fifty miles east of Campeche, situated in a narrow valley between a series of rocky hills, and has to be approached by precipitous paths over the hillsides, and thence down the beds of dry arroyos whose yearly freshets wash away all vegetation. Ten buildings, including one called the Palace, and two mounds were explored, and some miscellaneous excavations were made—all of which are described in the author's paper (Field Columbian Museum), with figures of the buildings and the objects. Pottery and flaked stone implements were plentiful, but polished implements and specimens of sculpture were exceedingly rare. The flat under-surfaces of the ceiling stones of the vaulted chambers seem to have contained very elaborate designs; in another chamber portions of a paint-

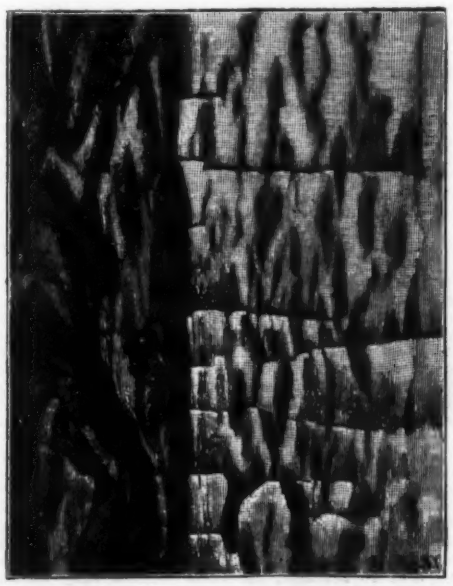


FIG. 3.—FRONT VIEW OF THE EROSIONS.

ing were still partly preserved; in another, curious drawings or glyphs in strong black lines once existed; in another was a painted human figure, of which only the flowing head-dress, a portion of the face, and certain devices issuing from the mouth and probably indicating speech, now remain. The mysterious red hand was found painted in various places, and in one a human hand in blue pigment was found, the impression of which was so fresh and perfect in places that even the minute lines of the skin were visible. In ten years of investigation among the ruins of Yucatan and Campeche not as many specimens of worked obsidian were found as could be picked up in half an hour among certain Mexican ruins; but traces of ancient fabrication of flint implements were more plentiful than anywhere else.—Popular Science Monthly.

MAGNETISM.*

THE methods by which the permeability and the hysteresis of iron were at first investigated were laborious, even in the hands of people used to physical research. Several inventors have applied themselves to the task of providing simpler means of making such measurements. Having some personal experience—which began earlier than most people's—in this matter of magnetic testing, I have endeavored to provide apparatus suitable for workshop use. Three of the instruments devised with this object are before you. The first is a hysteresis tester, Fig. 1, which has come into extensive use for measuring directly the hysteresis of sheet iron such as is employed in the cores of transformers and dynamo armatures. The specimen is a little bundle of strips, and it is made to revolve between the poles of a permanent magnet which is free to swing upon a knife edge. At each half turn the magnetism in the specimen, induced by the permanent magnet, is reversed, and this reversal involves hysteresis, which shows itself by making the magnet become deflected even more rapid and direct would be useful I lately brought out a third instrument, the magnetic balance, Fig. 3, which by, so to say, weighing the attraction between the test-bar and a fixed magnet, allows the induction produced by a particular value of the magnetizing force to be read directly upon a divided scale.

The various stages in the process of magnetization and the character of magnetic hysteresis will be made more intelligible if I show you in action another instrument which I call a magnetic curve tracer, which enables the motion of a small mirror to exhibit magnetic curves upon a screen. The mirror receives two components of motion; it turns horizontally by amounts which are proportional to the magnetizing force, and vertically by amounts which are proportional to the magnetic induction in a magnetic circuit of iron which forms part of the machine. Hence a spot of light reflected on the screen from the mirror traces out a curve which shows how the induction changes as the magnetizing force is changed. By reversing the magnetizing current repeatedly we make the iron go over and over again through a cyclic process of magnetic reversal,

The effects of temperature on magnetic quality have a direct bearing on some of the engineering applications of magnetism. Some of those effects are immediate, and some only show themselves when the iron has been heated for a considerable time. The immediate effects of heating were examined by Hopkinson, and more lately they have been the subject of an excellent investigation by Mr. D. K. Morris. Briefly, the general effect of heating is to increase the permeability and reduce the hysteresis of iron until a certain critical temperature—about 780° C.—is reached, when iron loses nearly all its power of being magnetized. The change happens somewhat suddenly, for at temperatures only a little lower than that the permeability is very great, and the hysteresis exceedingly small. The curve, Fig. 4, taken from Mr. Morris's paper, shows how the maximum permeability alters as iron is heated. There is a general rise in permeability, subject, however, to several set-backs in the course of the rise. The first of these happens about 250° C., the next between 400° C. and 500° C., and the greatest about 760° C. Now compare this with the curve shown in Fig. 5,

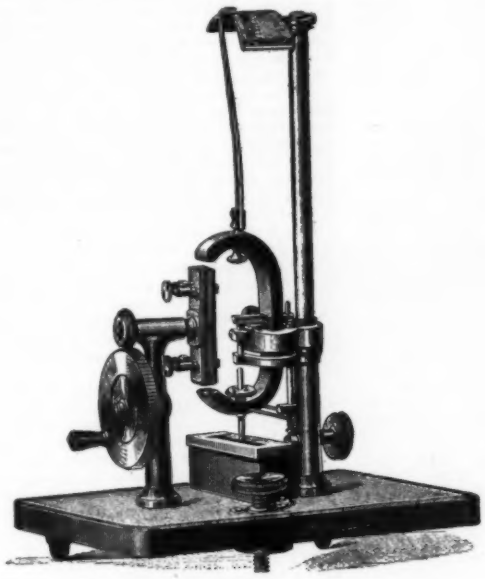


FIG. 1.

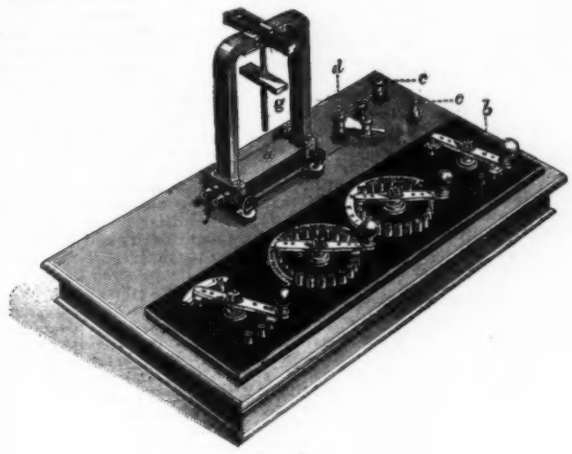


FIG. 2.

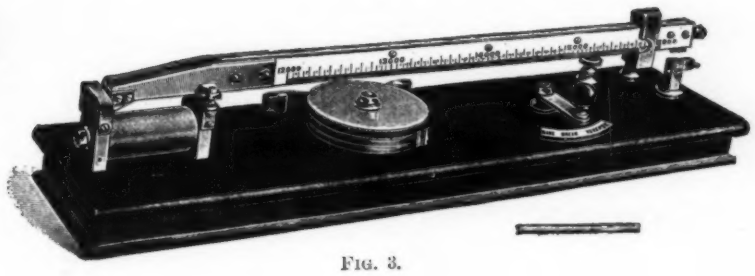


FIG. 3.

FIG. 5.

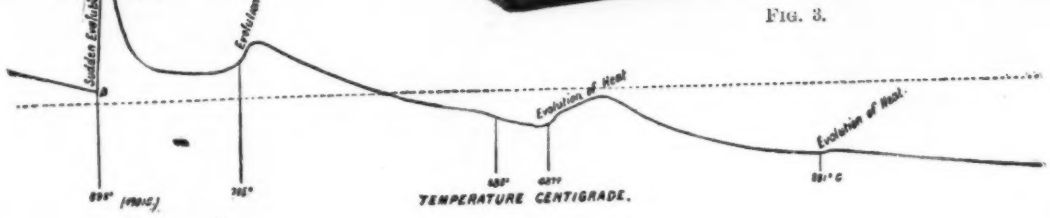


FIG. 4.

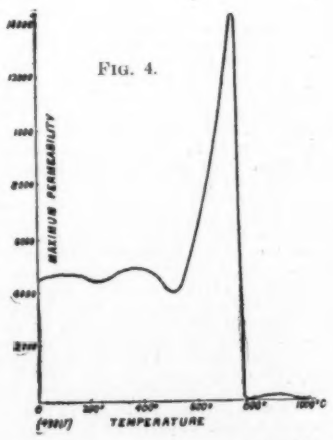


FIG. 6.

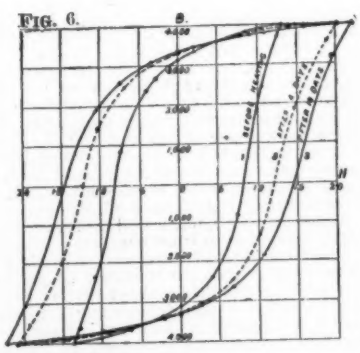
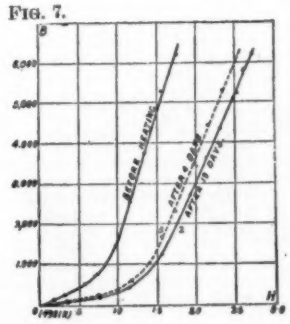


FIG. 7.



APPARATUS FOR INVESTIGATING PERMEABILITY AND HYSTERESIS OF IRON.

over more or less. The amount of the deflection is read off by a pointer on a scale above, and gives a very simple measure of the hysteresis. The second instrument, Fig. 2, I call a permeability bridge. It allows tests to be made of the permeability of forged iron or cast steel in a way that is analogous to the measurement of resistance by Wheatstone's bridge. The specimen is turned in the form of a rod, and is tested against a standard rod of the same size whose permeability curve has been determined beforehand. What the bridge actually determines is the ratio of the magnetizing forces which will produce the same magnetic induction in the two rods, and by making this comparison for several different strengths of magnetizing current we have data for drawing the permeability curve for the rod under test. The process performed in this way is immensely simpler than the older method of testing, and it gives the curve as completely as may be desired. But under the impression that something with the result that the spot of light traces out a closed curved showing hysteresis. The moving parts of the instrument are made light, so I can quicken the process sufficiently to make the path of the spot appear, by persistence of vision, as a continuously luminous curve.

There are many interesting features of the magnetizing process on which, if time permitted, we might dwell. Effects of stress and effects of temperature have been very fully examined, with results which, in some particulars, are of practical import. One point which deserves special notice, on account mainly of its physical interest, is that when we change the state of a piece of iron that is being magnetized, whether by heating or cooling, or by pulling, or pushing, or twisting or vibrating it, the first effect of the change in temperature, or in stress, is to reveal a certain instability in the magnetism, and it is only after several repetitions of the change of state that things settle down and the proper effect of the alteration in condition exhibits itself. This is a phenomenon closely associated with hysteresis and we shall see presently that the molecular theory which explains hysteresis explains it also.

which represents one of Sir W. Roberts-Austen's beautiful investigations of the rate at which a piece of iron cools from a white heat. There is a steady fall of temperature except at certain places where some internal convulsion happens which is associated with the giving out of heat. Note the points where this occurs, and you see that they connect themselves with what I have called the set-backs in the other curve. We may even trace a connection between the highest of these breaks and a change which is slightly apparent in Morris's curve about 900° C., though the iron then retains very little magnetic quality at all. The inference seems pretty plain that not only at the great magnetic critical point is there a transformation of structure associated with absorption of heat during the heating of the iron, but that a similar connection holds at the other points of arrest.

But it is with the effects of long-continued heating that engineers are more concerned. It was observed that transformers lost some of their efficiency after they had been kept at work for some weeks or months, and that this was due to an increase of hysteresis in

* From a lecture delivered by Prof. James Alfred Ewing, F.R.S., before the Inst. Civil Engineers, London.

the iron core. Mr. Mordey proved that this increase of hysteresis resulted from the prolonged baking of the iron; a transformer at work becomes warm, largely because of the heat developed through hysteresis, and long exposure to a somewhat high temperature gradually alters the iron for the worse. The amount of this deterioration depends much on the degree of heat, and it is by no means the same for all specimens of iron; sometimes iron which is at first particularly free of hysteresis is most affected. Mr. Roget, who has investigated the matter in my laboratory, has found that continuous exposure for seven days to a temperature of only 160° C. has actually trebled the hysteresis of one very good specimen; but, what is most curious, a further continuation of the baking at the same temperature causes improvement to set in. The hysteresis passes a maximum, which comes earlier the higher the temperature of the baking, and then tends to lessen when the baking is further prolonged. The curves, Figs. 6 and 7, relate to a ring of sheet iron heated at 200° C., and show the kind of change which happens, as well as how the changes in hysteresis are associated with corresponding changes in the permeability of the iron. At that temperature the maximum is passed after a comparatively short period of baking.

This augmentation of hysteresis is a serious matter in transformers, and much attention has been given to getting iron which will not show it. Some specimens were lately submitted to me which were not only extraordinarily free from this objectionable characteristic, but had much less hysteresis even initially than any iron I had tested before. Makers are naturally reticent as to the processes of manufacture by which such results are obtained, and they have in some cases an additional and excellent reason for reticence in the fact that they really do not know what the conditions are to which the good results are to be ascribed. It is probable that light will be thrown on these difficult questions by the application of the microscope, a tool the value of which the metallurgist is now fast coming to recognize.

Much that is obscure in the phenomena of magnetization is made plain when we come to consider the molecular theory of the process. It is an old idea, due originally to Weber, that the molecules of iron are always magnets, and the process of magnetizing a piece of iron is merely to turn the molecular magnets round so that they face one way. At first they are pointing every way at random, but when magnetizing force is applied they gradually turn, and, finally, when saturation is attained, they all lie with their magnetic axes exactly along the line of force. To account for their not all turning at once, and also for the fact of residual magnetism, various hypotheses have been framed, as, for instance, that the turning of each molecule is resisted by what may be described as a miniature friction brake. A good deal of meditation on this matter led me to the conclusion that no such hypothesis was needed. The gradual turning of the molecular magnets, and all the phenomena of hysteresis, are simply results of the mutual actions between each molecule and its neighbors. We may demonstrate this by means of a model consisting of a large number of permanently magnetized needles set on pivots near together. When a weak magnetic field is applied, the pivoted magnets turn slightly and in a quasi-elastic manner, free from hysteresis; but as the field is strengthened the ties between them are overcome and instability ensues, the original groups break up, and the magnets enter into new combinations. Finally, as the applied field becomes stronger still, complete parallelism is gradually approached.

Thus the model reproduces with perfect fidelity what I have called the three stages of the magnetizing process. Moreover, the dissipation of energy involved in the breaking up of molecular combinations corresponds exactly to what we know of hysteresis. The model shows not only how this cause of hysteresis affects a cyclic process of magnetization, but how it explains the instability which I mentioned as the first thing noticed when we heat, or cool, or stress a piece that is being magnetized. Any change of condition precipitates the breaking up of groups which were, so to speak, hesitating on the verge. By using a model with a large number of little magnets, we get the aggregate external magnetic effect of the group to vary with variations of the field exactly in the way in which the magnetism of iron varies, and the model indicates not only the main, but even the minor features of the process. It was pointed out by Mr. James Swinburne that my theory would involve this curious result, that a piece of iron when revolved in a very strong magnetic field would exhibit no hysteresis, though it shows much hysteresis when revolved in a weaker field. The prediction was experimentally verified by Prof. Baily. We may illustrate this in the model by turning round the plate which carries the little pivoted magnets, when you will notice that breakings up of molecular groups occur when the field is weak, but not when the field is strong.

I think this model has a bearing on other physical matters which concerns engineers. It is easy to believe that between the molecules of materials there are other polar forces acting, distinct from magnetic forces, and common to non-magnetic as well as magnetic materials. When we make one body slide on another, these intermolecular forces acting across the surface of contact may cause the molecular groups near the surface to become broken up and reconstituted, thereby giving rise to the dissipation of energy which we are familiar with under the name of friction. The action will be apparent if we make one group of the little pivoted magnets slide past another group. We may go further and say that all non-elastic deformation of solid bodies by strain is probably an action of the same kind. Experiments which I have lately carried out, in conjunction with Mr. W. Rosenhain, have shown that the plastic straining of metals occurs through a multitude of separate slippings of one part on another, in each of the crystalline grains of which the metal is made up. The model may be taken as illustrating how with molecules possessed of polar forces such slips involve an expenditure of work. But this is taking me away from my already too comprehensive text.—Engineering.

It is said that the De Beers diamond mine, in South Africa, is at present the largest dividend payer in the world. In 1898 it paid no less than $7,087,300.

ELECTRICITY AS AN EXACT SCIENCE.

By HOWARD B. LITTLE, in Knowledge.

SINCE electricity has become so great a factor in our daily lives, the experience of every man, woman, and child, throughout every civilized country in the world, has been enormously widened; or opportunities have been constantly given for such widening. Nor is this all; the far-reaching "fluid" is exercising a distinct influence on the savage. But it is sufficient for our present purpose merely to note this fact, without entering upon any discussion of it.

It will not be too much to assert that the popular use of electricity has introduced a new order, or class, of experience. This seems a painfully trite remark when one considers that every business or profession requires its own specially trained workers; but what may be termed here "electrical experience" exhibits such a characteristic series of features that its consideration, besides being of interest, should also be profitable. To commence with, the idea of its being possible, by the motion of a relatively tiny lever here, to send messages to the Antipodes, seems to have opened up a new field of thought, which has in a manner been cultivated by the public's reception of such messages here, for the public is training daily to live at a greater rate, to receive its news more rapidly, and to travel faster. To all this it is the electrician's business to attend. As typical instances of the kind of task he should set himself may be mentioned the attainment of a higher speed in signaling, and an increase in the number of messages which, at one time, may be sent through the same line. The latter consideration will, as a rule, resolve itself into a question of maintaining the absolutely synchronous motion of two instruments at opposite ends of the line.

Another point for his consideration is the maintenance of absolute regulation of supply to light and power mains. The question of fuel economy may very well be referred back to the mechanical engineer, because the efficiency of a good dynamo is generally some six or seven times as great as that of a good steam engine; in fact, as it has so often been pointed out, an enormous percentage of fuel is wasted between the stoker's shovel and the pulley of the dynamo.

Unfortunately, man is not endowed with an electrical sense; he has to rely entirely on experience to ascertain the presence of electricity. And in some instances it is wonderful with what rapidity such experience can be brought into play. To quote a simple instance, and one of every-day occurrence. Suppose a house be "wired" and connected with an alternate-current station. The shock to be obtained from the fuse connections, or any similar points on the circuit, would be quite sufficient to startle anyone unaccustomed to such shocks, and should such an individual be at the time upon a ladder, it is quite possible that he would tumble off. Yet, to the electrician it is nothing, because, brief as the contact would in all probability be, he has yet had time to bring his experience to bear before giving the involuntary jump.

Again, it is electrical experience alone which can enable us to rapidly grasp all the details of a system of electrical connections, which may involve the use of dozens or hundreds of connecting wires. And the ideas of self-induction and mutual induction seem to the layman a complete upsetting of all his preconceived notions, while he is further appalled to learn that he will have to regard these as existing in definite quantities, under definite conditions; and in consequence subject to mathematical investigation. But, just as some "hyper-mathematical" minds have a conception of a fourth dimension, even so is this among electricians, in that to some these quantities assume a far more concrete entity than to others.

Turning now to quite another class of experience which the electrician must cultivate. He is called upon, more than any other scientist in these times, to explain to the non-scientific public. The less intelligent section of this latter community will, as a rule, be quite satisfied that they thoroughly understand the working of any apparatus if once they have been informed that it is electrical; and under certain circumstances it becomes the electrician's painful duty to undeceive them, and, with all the tact at his command, to insinuate that they really know nothing whatever about it. On the other hand, there is the individual who wants to know, and who will ask questions. In this connection the average electrician suffers more than all the members of any Foreign Office ever constituted, for two reasons; first, he is expected to make clear, to the class of questioner aforesaid, in the course of a few instants, what it may have taken him many years to arrive at a just appreciation and understanding of; and secondly, because the lay mind, having from childhood been familiarized with the phenomena of light, heat, and sound, never realizes that it has no information whatever as to what they are; consequently, by some curious process of reasoning, or want of reasoning, the impression prevails that any electrician who knows his business should be able to tell at once what electricity is. In this connection our esteemed contemporary "Mr. Punch" did us a great service many years ago, when, representing himself as having been asked to state what matter was, he replied somewhat in this way: "Matter, matter. Ah! yes, matter. Well, it's—well, no matter." But "Mr. Punch" has many privileges to which the humble tramp toiling on the road of science is in no way entitled. Yet, seriously, it is a serious matter. Only a short while back I was asked, by a man whose intelligence I consider much above the average, "What are X-rays? I want to make some." And there is yet another phase of this trouble. The "man in the street" clings to certain ideas, cherishes them, and absolutely refuses to part with them. For example, it is quite impossible to prevail on the majority to abandon their deep-rooted conviction that the phonograph is an electrical apparatus. In short, it will be noted that so far as these points alluded to are concerned (and indeed with reference to many others), the electrician requires and must cultivate a certain class of experience which is to a great extent unknown in other callings.

But nothing we can mention in this world is an unmixed blessing. While speaking of experience we must bear in mind that at times it may (under suitable conditions) become a distinct source of error. Reverting to first principles, under ordinary conditions of life we are justified in saying that where we can neither see nor hear nor feel the presence of anything, there is nothing present. We are so used to the ubiquity of the mixed gas air that we do not trouble ourselves to mention it, and so we have such an expression as "an empty box." This is hardly to be regarded as contempt due to familiarity, but rather as an error, introduced by too wide an experience. Similarly, the student of electrical science has to be brought to realize that even though he cannot see, hear, or feel electricity, yet it may be present, and he has, as already pointed out, to look for its effects rather than for it.

While it is possible for electricians to learn a great deal from their failures, yet it frequently happens that the next undertaking of a similar nature to that which was not successful is approached with a distinct want of heart, and it will scarcely be too much to state that every electrical failure which comes to the knowledge of the public exercises a most pernicious effect upon them. Witness the trouble experienced in order to capitalize the earlier Atlantic cables, and note that the Royal Albert Hall, of which Londoners are justly proud, is not yet electrically lighted. Further, the public having noticed certain electrical failures have adopted the catch words "That shows the difference between theory and practice." For this there are two causes; they mis-apply the experience they have, and overlook the fact that any idea which works out satisfactorily on paper, but not in practice, had some essential point or points omitted in its theoretical consideration, or "on paper."

There exists a most unfortunate tendency to consider parrot, or monkey-like, imitation an exercise of experience, if not of the imitators at least of some constituted authorities. Also, there is great and serious liability to error from the fact that statements by such authorities are frequently very badly reported where things electrical have been spoken of. Speaking of imitation, it is almost amusing to observe that municipal bodies are now adopting very frequently a curious precedent with reference to electrical undertakings. Having decided to install the electric light, or to undertake the construction of an electrical tramway, the body in question will depute some two or three of its number to go and inspect the system or systems in use by other such bodies. Speaking gently of this practice, one is bound to admit that it seems clumsy and expensive.

When the results achieved by Tesla, Röntgen, and Marconi were first announced, the majority of electricians found that to become thoroughly conversant with their full import it was actually necessary to abandon many of their preconceived ideas, and even then, what they had been led to regard as well-founded conclusions, derived from past experience, still formed something of a stumbling block. Similarly, an electrician who has become thoroughly used to direct-current work will, if he suddenly finds himself called to undertake investigations with reference to alternating currents, for some time to come find much of his past experience (though perfectly accurate in so far as it went) a decided nuisance to him, for the time being at least. It might be urged that these latter instances tend to show the danger arising from incomplete experience, rather than the danger of certain experience; but this contention cannot be allowed, for, returning to one of our previous illustrations, the error which usage permits in the expression "empty box" is not due to the fact that we have no experience in vacuo.

Perhaps of all the errors into which electricians as a body have ever fallen, solely on account of commercial electrical teaching or experience, the one most widely spread was that which led them (well within the past ten years) to deride the teaching in schools of "frictional electricity." It used to be said that to teach a boy what would happen when silk, or sealing wax, or glass, was rubbed, was a mere waste of time, because it was not the electricity of commerce. It was pointed out that "frictional electricity" had but two commercial applications, for it was only made use of to de-electrify silk, when in the process of manufacture it became electrified, and hung together with a tendency to become entangled, and to electrify the ink contained in the telegraphic siphon recorder. When, later on, this latter field for the remunerative use of the despised form of electricity was no more (owing to the introduction of a clockwork tapping apparatus which was found more convenient as a means of making the ink "jump" out of the tube) the electrician's tolerant smile at the "science master" became something painfully like a grin. But all that has been changed by the three men just mentioned (purposely in conjunction, though their work has been independent, and productive of widely different results). Before leaving this point, let me confess that I personally did my best to become one of the broadest grinners at the "science master." All I can say in extenuation is that, having cultivated a certain class of experience, I fell into the pit which I had dug unconsciously for myself, and, arrived at the bottom—well, I had good company there. Yet the value of experience must be by no means under-rated. Perhaps the plain statement of fact is best expressed by the assertion that among electricians, particularly, it requires great experience to arrive at a just appreciation of the value of experience, and a wide experience to make a proper use of experience.

THE ELECTRIC ARC.

AT a meeting of the English Institution of Electrical Engineers, recently, a very interesting discussion took place on Mrs. Ayrton's paper. Prof. Fleming said that although the electric arc had now been known for the greater part of a hundred years, yet our knowledge of it had advanced very little. The phenomena presented were those of the flow of current through a column of vapor, and in his opinion they were very similar to what happened in the electrolysis of liquids. It seemed to him that the carbon molecule was split up into two ions, the negative ion having a much greater velocity than the positive ion. There was, therefore, an accumulation of negative carbon ions forming a cushion on the positive pole, the crater of which was formed by the bombardment of the ions. Starting with this hypothesis, it was easy to show that many of the curious experimental results observed by Mrs. Ayrton followed easily by considering the chemical actions that took place in hissing arcs. Capt. Abney stated that many years ago, when pursuing spectroscopic research with the aid of an arc lamp, he

had observed most of the phenomena which are now exciting such interest. In particular, he had observed that just before hissing commenced the arc began to rotate very rapidly. He made the suggestion that if the various kinds of electric arc were examined and mapped spectroscopically, a great deal could be learned that could be found out by no other means. It was interesting to learn from Capt. Abney that he had anticipated Mr. Trotter's discovery of the rotation of the electric arc by many years, and the modesty with which he made his claim now was only equaled by the magnanimity with which he allowed Mr. Trotter to claim all the credit at the Royal Society meeting some eight years ago.

SELENIPEDIUM MACROCHILUM GIGANTEUM GRANDE.

OUR illustration in our SUPPLEMENT this week was drawn for us by Mr. Worthington Smith at the meeting of the Royal Horticultural Society on May 16, but we were not fortunate enough to be able to examine the plant at close quarters. It seems as if the dorsal sepal was absent, the anterior one (of two united) is broad at the base, and tapering at the apex into a long point; the two lateral petals are also prolonged into long, twisted, ribbon-like tails; the third petal of this series is the lip, which presents its usual character. Within this outer series there appear to be other three long-tailed segments, which may be representatives of the outer three stamens, which, in Cypripedium, are usually abortive. The column we had no opportunity of inspecting. Whether this interpretation of the flower be correct or not, there is no question as to its ornamental character. The hybrid has as its parents C. grande and S. caudatum Lindeni; and it was shown

SELENIPEDIUM MACROCHILUM GIGANTEUM GRANDE.

by Messrs. J. Veitch & Sons, Chelsea.—Gardeners' Chronicle.

THE PROPOSED MAGNETIC SURVEY OF THE UNITED STATES.*

THE present superintendent of the Coast and Geodetic Survey, Prof. Henry S. Pritchett, perceiving the need of expansion in the magnetic work of the survey, has brought about the formation of a separate division, known as the Division of Terrestrial Magnetism of the United States Coast and Geodetic Survey. The chief of this division is to be Dr. L. A. Bauer, who will have full control of all magnetic work, both in the field and in the office.

The following preliminary outline will serve to give some indication of the character and scope of the work it is proposed to carry out with the enlarged opportunities.

SECULAR VARIATION INVESTIGATIONS.

The best evidence of the great demand for secular variation data is the fact that, thus far, eight editions of Schott's secular variation paper have been successively issued by the survey.

In all matters relating to the re-location of land boundaries, where it is frequently necessary to know the precise amount of angular change in the direction of the magnetic meridian since the first or original survey, the Coast and Geodetic Survey is recognized throughout the country as the ultimate authority. The amount of money saved to landowners by such authoritative determinations as the survey is able to furnish can scarcely be estimated. It certainly exceeds many times the total amount to be spent for magnetic work.

Every effort will be made in the future to multiply and verify the secular variation data, and requests for information on the part of surveyors will be encouraged in every possible manner and true meridian lines established for them.

This involves the determination of the magnetic elements, declination, dip, and intensity at various points throughout the land. Exactly how close the stations shall be to each other depends upon the special purpose to be accomplished with the means at hand and the magnetic character of the regions involved.

A magnetic survey has peculiar difficulties to contend with; for the quantities to be experimentally determined are forever undergoing changes — some periodic, others not periodic. A magnetic survey must, therefore, be made to refer to some particular moment of time, and such means must be taken as to enable one to reduce all the measurements, not only to the selected epoch of the survey, but also, as occasion may demand, to some other epoch in the near past or in the near future. Means must also be taken for the proper elimination of all such errors as are to be referred entirely to the particular magnetic instrument used, i. e., instrumental errors.

NUMBER AND DISTRIBUTION OF STATIONS.

At how many stations will it be necessary to determine the magnetic elements? The areas of the countries at present belonging to the United States are, approximately, as follows:

United States	3,025,600	square miles.
Alaska	577,390	"
Hawaiian Islands	6,250	"
Porto Rico	3,530	"
Total	3,612,770	"

Hence the area is equal to that of entire Europe, or about one-fifteenth of the entire land area of the globe. As magnetic surveys have been especially prosecuted in Europe, it will be of interest to note the density of distribution of the magnetic stations in two recent, fruitful magnetic surveys, viz., that of Great Britain, where there was one station to every 139 square miles; and that of Holland, embracing one station to every 40 square miles.

Suppose one station is decided upon, on the average, to every 100 square miles—an end that may be obtained some day—then the determination of the magnetic elements would be required at 30,000 stations within the United States. At the rate of 400 stations a year, the magnetic survey, as detailed as this, would require for its completion at least seventy-five years. It is not well, however, to have a magnetic survey extend over such a long interval of years. The errors incurred in reducing the observations to a common epoch would greatly exceed the errors of observation.

It is evident, then, that a very large number of observers and instruments would be required to complete the survey within a short interval, say ten years at the most, or a less detailed survey will have to be undertaken.

The plan of conducting a magnetic survey of the United States which appears to be best suited to the present conditions, and one that it is possible to carry out within a reasonably short time, is as follows: To make first a general magnetic survey of the country with stations about twenty-five to thirty miles apart; then, as opportunities present themselves, to add stations in the magnetically disturbed areas. The observations at the "repeat stations," made from time to time, will furnish the proper secular variation corrections.

The great advantages of this plan over that of attempting a greatly detailed magnetic survey at once, the steady progress of which over the entire country, on account of its extent, would necessarily be very slow, will be readily perceived. It will be of interest, however, to point out that the plan, as briefly outlined, will make it possible, within a reasonable time, to construct two sets of magnetic maps for the same epoch, each set based upon a different distribution of the stations. An opportunity will thus be afforded, as in the case of the magnetic survey of Great Britain, to obtain some idea of the accuracy with which the isomagnetic lines can be determined. The satisfactory solution of this question will serve as a valuable guide in future magnetic work.

Various State geologists, incited by the example set by the State Geologist of Maryland, Prof. William Bullock Clark, either have already made plans, or are making plans, for detailed magnetic surveys of their respective States in co-operation with the Coast and Geodetic Survey.

MAGNETIC SURVEY OF OCEAN AREAS.

Provisions for the determination of the magnetic elements at sea are being made. With the many vessels at the service of the Coast and Geodetic Survey, exceptional facilities for this purpose will be afforded. In fact, one of the chief duties of the survey is the supplying of magnetic data to the mariner. From an economic standpoint this feature of magnetic work is the one really of the greatest practical importance. In recognition of this fact, the survey vessels will hereafter take advantage of every opportunity to obtain the magnetic elements on sea and on shore.

MAGNETIC OBSERVATORIES.

The rapid, successful, and economical execution of the plans as above briefly outlined requires the establishment, at certain points, of magnetic observatories, where the countless variations in the earth's magnetic force are continuously and automatically recorded, enabling thus the proper corrections to be applied to observations made at stations at any hour of the day.

The present plans contemplate the establishment of a magnetic observatory near Washington city—this will be the Central or Standard Observatory; another near Seattle, State of Washington; one in the Hawaiian Islands, and one in Alaska. With the co-operation of the observatories at Toronto, Mexico, and Havana, and with the aid of secondary or temporary observatories established as occasion may demand, the areas to be surveyed will be fairly well covered.

It is very much to be hoped, however, that the universities and colleges in the United States will seriously consider the establishment of magnetic observatories. Many an institution which lacks the means of making a reputation in astronomical work could still afford to inaugurate useful work in terrestrial magnetism.

The United States stands at the bottom of the list of civilized countries possessing magnetic observatories. Almost every European power of note maintains, not only one, but several permanent magnetic observatories. France has four already established, and four additional ones in process of erection; and progressive Japan, with its small strip of territory, has six continuously operating magnetic observatories.

The recent International Magnetic Conference recommended the establishment of a magnetic observatory at the Lick Observatory. It is earnestly to be hoped that this suggestion will be carried out. It is unfortunate that the San Antonio Observatory in Texas had to be abandoned. A permanent observatory should be re-established in this locality.

The scheme of work for the Coast and Geodetic Survey observatories will embrace, in addition to the regular magnetic work, observations in atmospheric electricity and of the electric currents within the earth. Such observations can be carried on with practically no additional cost, and yet add greatly to the value of the observatory work. Arrangements will likewise be entered into with the Potsdam Magnetic Observatory for the making of strictly simultaneous observations of a special character.

The plan of referring the initiation and prosecution of magnetic work in America to such a well-organized department as the Coast and Geodetic Survey, the work of which is recognized universally as of the highest order, will readily be seen to have decided advantages. In the first place, the machinery for carrying on the work is already to a great extent in existence. The observer engaged in goedetic or astronomical work can frequently include to advantage magnetic observations, and thus can often be saved the chief cost of magnetic work—the occupying of stations. Again, the care and refinement with which the geodetic and astronomical work of this bureau is carried out will ever be an incentive to keep the magnetic work of the same high order.

*Abridged from an advanced proof of a paper by Dr. L. A. Bauer in Terrestrial Magnetism and published in Nature.

VIBRATIONS OF THE ETHER.

A VERY interesting paper was read by Mr. F. W. Brauson, F.I.C., before the Leeds Naturalists' Club and Scientific Association on some recent discoveries in physical science.

Attention was first directed to the dissimilarity of radiations transmitted by the atmosphere and by the ethereal medium which pervades all space. Experiments were made with sound waves to illustrate the former, and with the Hertzian waves the latter. The gradations which may be observed between sound, light, heat, and electrical waves were demonstrated by means of models and diagrams, and a table showing a number of vibrations per second of various radiations was given as follows:

Vibrations per Second.	
288,224,000,000,000,000	Röntgen rays.
1,125,899,906,842,624	Photographic limit of solar spectrum.
562,949,953,421,312	Green light.
281,474,976,710,656	Infra red (photographic limit).
70,368,744,177,664	Heat rays of solar spectrum, lowest direct measurement.
67,108,864	Electric oscillations in Hertz resonator, 70 cm. diameter.
32,768	Audible vibrations, extreme upper limit.
4,096	Music, highest note.
32	Music, lowest note.
16	Water surface waves of minimum velocity.

The system of wireless telegraphy used by Marconi

was then demonstrated by means of Hertzian waves emitted from a Hertz radiator. A number of experiments with phosphorescent bodies, etc., and the Röntgen rays, were then shown, and, by means of a Tesla coil, so arranged as to give a rapidly alternating field, tubes of high vacua were illuminated without the intervention of conducting wires. The experiments were very numerous and of the greatest interest, and a large attendance of members testified to the appreciation of the labor which their preparation must have entailed.

THE EFFECT OF OZONE ON PHOTOGRAPHIC PLATES.

By E. ANDREOLI.

I READ some years ago in an extract from the Dublin Chemical and Philosophical Club that Dr. Emerson Reynolds stated that the latent image (i. e., the image before it is developed), when submitted to the action of ozone, was completely obliterated; not only was it impossible to develop it, but a second image might be retaken in the camera upon the same plate. This, he said, is against the mechanical theory of photography, and that it is due to chemical changes in the sensitive film. No doubt this action of ozone on sensitive photographic plates is not generally known. If ozone destroys a latent image on a photographic plate, why should it not restore to a fogged film its primitive properties? Why should it not oxidize the silver compounds which the white light has reduced? Starting from this fact that, according to this statement, ozone destroys the effect of the exposure of a photographic plate to light, I made the following experiments a few days ago:

In the dark room two dry plates were half wrapped in tinfoil and black paper, and then the non-protected films were for two seconds exposed to the white light of the sun, which on that day was very brilliant. Under ordinary circumstances the part of the film which has been struck by daylight would be inevitably fogged; it would no longer be able to take even the faintest image, and when dipped in the developer would simply turn black, because light has spoilt it and it has become utterly unavailable for photographic purposes. I ozonized the plates during about four minutes, and after this I placed them under a Roentgen tube, and in the usual manner I photographed an eye glass in its case. On the day before I had exposed two plates to the light of an incandescent lamp and ozonized them afterward, and this first experiment had been somewhat encouraging; two following ones, however, had been a complete failure; there was an image on the halves which had not seen the light; the other halves were as black as pitch.

The experiments to which I refer now were successful in that sense that the image of an eye glass in its case was visible on the whole surface as if the silver compounds of one-half of each plate had not been acted upon by light. I will not pretend that the two halves of each plate were equally transparent; this is a matter of detail; with more ozone (I had only four small luminous tubes) there would be no difference between the two parts of the plates, and the image would be as sharp on the halves which have seen the light as on those which have not seen it.

Capt. A. W. Abney in his "Instructions in Photography" speaks of general fog, by which he means the fog produced in development, caused by the partial reduction of the silver salt all over the film. This, he says, is probably due to the decomposition of the gelatine by long cooking, the products of which in the presence of a developer are apt to react on the silver salt and produce a partial reduction on it. The production of this kind of fog and electrical disturbances in the atmosphere are apt to go together. Another fruitful source of fog is the light admitted to the plates during preparation or development. Whatever may be the cause of the fog, if the emulsion be not hopelessly at fault, or if the plates have seen the light, according to Capt. Abney, who does not suggest the use of ozone, the remedies are the use of potassium biehromate, or the addition of cupric chloride, or of a few grains of ferricyanide of potassium with a little bromide of potassium.

Prof. R. Meldola is, I think, the only specialist in photography who has treated this question of the disappearance of the invisible image, which he considers as a photo reduction product. "Such a compound," says he (Chemistry of Photography, page 197), "like all reduced products, is susceptible of oxidation. In accordance with this view of the composition of the invisible image, it is found that the latter can be destroyed by oxidizing agents, such as nitric acid, the chromates, permanganates, metallic perhaloids, which are equally effective in destroying the invisible image. It is generally believed also that atmospheric oxygen (or ozone) plays a part in the obliteration of the invisible image. The destruction of the image may, in such a case, be due to indirect rehalogenization, that is to say, the oxygen or ozone may oxidize the halogenized sensitive, and so liberates the halogen, which then attacks the reduction product."

The above-described experiments confirm the statement made by Dr. Emerson Reynolds on the erasure by ozone of the image impressed on the film, and show the possibility of restoring to the plates their sensitiveness. Beyond the interest which they present from a scientific point of view, they did not seem, however, to present any particular character of usefulness; but a friend has suggested that in the works where photographic plates are manufactured, the ventilation by ozone may prove beneficial in removing the many causes which fog the films.—English Electrical Review.

Moistening of plaster of Paris is best effected, according to the Thon Industrie Zeitung, with filtered rain water or with sour milk. Within 24 hours the mixture is extraordinarily hard. Addition of fine marble dust increases the hardness. Addition of 1 part of sal ammoniac to 15 parts of gypsum is also recommended. The magma is best prepared by placing the powdered gypsum into a dish in the form of a cone and slowly pouring into the dish water or sour milk until the liquid has been absorbed up to the apex of the cone. Not until then should the mixture be stirred.—Drog. Ztg.

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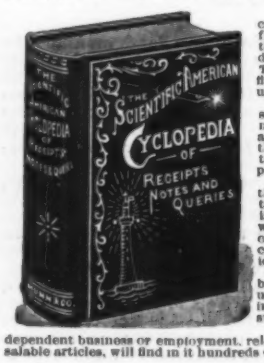

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